DOCUMENT RESUME

ED 073 943 SE 015 850

AUTHOR	McLeod, Douglas B.
TITLE	The Effectiveness of an Inservice Program for Implementing an Activity Approach to Learning Mathematics in the Elementary School.
INSTITUTION	Wisconsin Univ., Madison. Research and Development Center for Cognitive Learning.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Research and Development Centers Branch.
REPORT NO	TR-245
BUREAU NO	BR-5-0216
PUB DATE	Nov 72
CONTRACT	OEC-5-10-154
NOTE	194p.
EDRS PRICE	MF-$0.65 HC-$6.58
DESCRIPTORS	Curriculum; Doctoral Theses; *Elementary School Mathematics; *Elementary School Teachers; *Inservice Teacher Education; Instruction; Mathematics Education; Objectives; *Research; Teacher Education
IDENTIFIERS	*Developing Mathematical Processes

ABSTRACT

The purpose was to determine the effectiveness of an inservice program designed to help elementary school teachers implement an activity approach to learning mathematics in their classroom using Developing Mathematical Processes (DMP). Thirty-eight kindergarten and first grade teachers participated. The success of the inservice program was judged by comparing the teachers' performance on 24 objectives with performance criteria based on the results of an assessment of the behaviors of successful experienced DMP teachers. Results showed that the teachers exceeded the criterion levels on 13 of the objectives; it was found also that teacher performance did not seem to be related to teacher characteristics such as age, experience, or professional activities. Behaviors for which teachers did not reach criterion levels included asking probing questions, describing the mathematical processes emphasized by DMP, and managing instruction to provide for individual differences. Seventy-six percent of the teachers were judged to have done an adequate job of implementing an activity approach. (Author/DT)

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THE WISCONSIN RESEARCH AND DEVELOPMENT CENTER FOR COGNITIVE LEARNING

The University of Wisconsin Madison, Wisconsin

SE 015 850

U.S. Office of Education Center No. C-03 Contract OE 5-10-154

ED 073943

Technical Report No. 245

THE EFFECTIVENESS OF AN INSERVICE PROGRAM FOR IMPLEMENTING AN ACTIVITY APPROACH TO LEARNING MATHEMATICS IN THE ELEMENTARY SCHOOL

Report from the Program 2 Component
Analysis of Mathematics Instruction

by Douglas B. McLeod

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November 1972

This Technical Report is a doctoral dissertation reporting research supported by the Wisconsin Research and Development Center for Cognitive Learning. Since it has been approved by a University Examining Committee, it has not been reviewed by the Center. It is published by the Center as a record of some of the Center's activities and as a service to the student. The bound original is in The University of Wisconsin Memorial Library.

The research reported herein was performed pursuant to a contract with the United States Office of Education, Department of Health, Education and Welfare, under the provisions of the Cooperative Research Program. The opinions expressed in this publication do not necessarily reflect the position or policy of the Office of Education and no official endorsement by the Office of Education should be inferred.

Center No. C-03 / Contract OE 5-10-154

STATEMENT OF FOCUS

Individually Guided Education (IGE) is a new comprehensive system of elementary education. The following components of the IGE system are in varying stages of development and implementation: a new organization for instruction and related administrative arrangements; a model of instructional programing for the individual student; and curriculum components in prereading, reading, mathematics, motivation, and environmental education. The development of other curriculum components, of a system for managing instruction by computer, and of instructional strategies is needed to complete the system. Continuing programmatic research is required to provide a sound knowledge base for the components under development and for improved second generation components. Finally, systematic implementation is essential so that the products will function properly in the IGE schools.

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A self-renewing system of elementary education is projected in each participating elementary school, i.e., one which is less dependent on external sources for direction and is more responsive to the needs of the children attending each particular school. In the IGE schools, Center-developed and other curriculum products compatible with the Center's instructional programing model will lead to higher morale and job satisfaction among educational personnel. Each developmental product makes its unique contribution to IGE as it is implemented in the schools. The various research components add to the knowledge of Center practitioners, developers, and theorists.

ACKNOWLEDGMENTS

I wish to express my thanks to my adviser, Professor John G. Harvey, for his support and encouragement during my years of graduate study, to Professor Philip E. Miles for his careful reading of the text, and to Professors Michael N. Bleicher, Thomas A. Romberg, and Donald W. Crowe for serving on my committee.

Also, I want to acknowledge the support of the Wisconsin Research and Development Center for Cognitive Learning and its staff in the conduct of this study. The staff of the mathematics project has been particularly helpful, as has the field test staff of the Quality Verification section. In addition, the cooperation of the schools and teachers who were involved in the study was greatly appreciated.

Finally, thanks must go to my wife, Susan, who always found time to assist me in my work, even though she was writing her own dissertation at the same time.

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ABSTRACT

The purpose of this study was to determine the effectiveness of an inservice program designed to help elementary school teachers implement an activity approach to learning mathematics in their classrooms. Characteristics of an activity approach include an emphasis on real-world problems, use of manipulative materials, and having children work in small groups, while the teacher is a resource person, not a lecturer, who asks students to validate their statements and who assesses children's achievement in order to provide for individual differences. Teachers need special materials if they are to implement an activity approach; in this study the teachers were provided with Developing Mathematical Processes (DMP), a new elementary mathematics program developed by the Wisconsin Research and Development Center for Cognitive Learning.

The inservice program was designed to help teachers achieve 24 behavioral objectives or competencies related to implementing an activity approach. These behaviors dealt with the use of instructional and assessment materials, the verbal behavior of the teacher, the organization of the classroom, the teacher's knowledge of mathematics, and managing instruction in order to provide for individual differences. The inservice program was conducted in two parts--a two-day workshop before school started, and a series of four one-hour inservice meetings during the first two months of the school year. The evaluation of the inservice program began at the conclusion of the inservice meetings, and continued through the first semester.

The evaluation procedures included classroom observations, questionnaires, and interviews. Appropriate instruments of each type were developed to measure teacher performance and other characteristics such as age, experience, and professional activities.

There were 38 kindergarten and first-grade teachers who participated in the study; these teachers came from four inner-city and four multiunit schools that were also participating in the small-scale field test of DMP.

The success of the inservice program was judged by comparing the teachers' performance on the objectives with performance criteria; these criteria were based on the results of an assessment of the behaviors of experienced DMP teachers who were believed to be successful in implementing an activity approach. The teachers in the study exceeded the criterion levels on 13 of the 24 objectives, and multiunit teachers reached the criterion levels on three additional objectives; teacher performance did not seem to be related to teacher characteristics such as age, experience, or professional activities.

The behaviors for which teachers did not reach the criterion levels included asking probing questions, describing the mathematical processes emphasized by DMP, and managing instruction to provide for individual differences. However, 76% of the teachers were judged to have done an adequate job of implementing an activity approach, and the inservice program appeared to be an effective means of improving teacher performance. The continuing series of inservice meetings was particularly effective in encouraging teachers to change their teaching practices.

Chapter 1

INTRODUCTION

During the past fifteen years, substantial changes have taken place in the elementary mathematics curriculum; these changes have been accompanied by many recommendations for improving the teaching of mathematics. Teachers have been asked "to present mathematics as the pursuit of the truth by a process of inquiry" (Cambridge Conference on School Mathematics, 1963, p. 26), and "to regard mathematics as a creative activity--something which one *does* rather than something which one learns" (Committee on the Undergraduate Program in Mathematics, 1971, p. 20). In addition to the concerns of mathematicians, research in developmental psychology indicates that mathematics teaching in the elementary school should provide children with an informal classroom atmosphere, including opportunities for using physical materials, for group interaction, and for learning independent of the teacher (Lovell, 1972). While these statements are vague about what a teacher should actually do, they imply that a mathematics classroom should be a place of inquiry and activity, where children learn mathematics actively rather than absorbing it passively. Many different terms have been used to describe this kind of mathematics teaching; in this study it will be referred to as an "activity approach to learning mathematics."

The study reported in this paper investigates the effectiveness of an inservice training program designed to help elementary school teachers implement an activity approach to learning mathematics. The importance of inservice training in implementing new approaches to mathematics has long been recognized. For example, the report of the Cambridge Conference on Teacher Training (1967) emphasizes that the greatest difficulty in implementing the goals of the 1963 Cambridge Conference lies in the problem of teacher training. And as Heathers (1967) points out, teacher education programs have generally not prepared teachers so that they can implement new ideas in education like an activity approach to learning mathematics. Further support for Heathers' comments comes from a study by Goodlad, Klein, and Associates (1970) that shows how attempts to implement new ideas in elementary schools have resulted in almost no change at all, except perhaps in the terminology used by teachers. In mathematics classrooms, for example, teachers often used "new math" programs, but the "old pedagogy" still prevailed. If teachers are to implement an activity approach successfully in their classrooms, then an effective inservice program--an inservice program that changes teacher performance--is clearly required.

While there has been a substantial amount of inservice training provided for teachers of mathematics during recent years, there is little evidence as to what kind of an inservice program might be effective in helping teachers implement an activity approach to learning mathematics. The study being reported here provides some of that evidence. In order to describe the study in more detail, it is first necessary to define more precisely what constitutes an activity approach to learning mathematics. The remainder of this chapter will include an overview of the inservice program and its objectives, followed by a statement of the specific questions that the study was designed to answer.

An Activity Approach to Learning Mathematics

An activity approach to learning mathematics has a number of important characteristics. First, such an approach emphasizes solving problems that are real to the child. Following the goals for mathematics instruction stated by Buck (1965), the teacher is expected to stress the relationship of mathematics to real-world problems. Measurement problems are an example of one way a teacher can use common situations to generate a substantial amount of elementary mathematics (Romberg, Fletcher, & Scott, 1968). This emphasis on problem solving links the activity approach with heuristic teaching, a concept based mostly on the writings of Polya; the relationship of heuristics to the teaching of elementary school mathematics has been discussed by Higgins (1970).

Certain other characteristics of an activity approach result from research in developmental psychology. This research, recently summarized by Lovell (1972), indicates that children should be provided with manipulative materials which help to make abstract mathematical ideas more concrete. Also, children need to work in small groups, discussing the problems they are solving and justifying their answers. Further, the teacher's role is not that of a lecturer, but rather that a resource person who helps students to make their own discoveries of mathematical concepts.

A third aspect of an activity approach is individualization, for children learn mathematics differently, and need different learning experiences. Therefore, the teacher needs to assess children's achievement and use that assessment information to provide instruction that is tailored to meet the needs of each child.

Another important feature, referred to by Biggs and MacLean (1969) as the essence of an activity approach, is variety--variety in the materials used, in the problems solved, and in the classroom organization employed. Thus the teacher should use physical objects, as well as pictures and written materials; he should pose a variety of problems related to a given idea, such as measuring on a number of attributes (length, area, volume, weight, time), rather than just one; and he should choose activities for large and small groups, as well as for individuals.

Implementing an activity approach in the classroom is not an easy task. It requires substantial changes in the teaching methods used by most teachers, as well as a variety of instructional activities and assessment materials. In the present study teachers were provided with Developing Mathematical Processes (DMP), an elementary mathematics program currently under development by the Analysis of Mathematics Instruction Project of the Wisconsin Research and Development Center for Cognitive Learning. (For a more complete description of the project, see Romberg & Harvey, 1969; Harvey, Romberg & Fletcher, 1969; Harvey, 1971; Romberg, in press.)

The DMP program uses an activity approach to learning mathematics in presenting concepts from the areas of arithmetic, geometry, and statistics and probability. The activities in DMP emphasize problems that come from the physical world of the child, and the findings of developmental psychologists are taken into account by providing manipulative materials and by giving children opportunities to work in small groups. An activity approach to learning mathematics should also provide for individual differences among students, and DMP includes appropriate assessment materials so that teachers can choose activities that are designed to meet the needs of individual children. Finally, DMP includes a variety of activities that give students many different opportunities to learn each new concept. Thus DMP is an elementary mathematics program that is appropriate for implementing an activity approach to learning mathematics. However, it is generally the case that teachers need more than just materials in order to implement an activity approach in their classrooms; they also need inservice training.

The Inservice Program and Its Objectives

The inservice program that was developed for the present study was designed to help teachers change their performance and implement an activity approach to learning mathematics using DMP materials. Unlike typical inservice training program for mathematics teachers in the elementary school, this inservice program was intended to be more than just a remedial course in mathematics content. Rather, the inservice program was designed to help teachers develop the behaviors needed for implementing an activity approach. These behaviors, which are listed in Appendix A, deal with the teachers' knowledge of mathematics as well as the techniques and procedures used in providing and managing instruction through the use of an activity approach. The developers of DMP have identified these behaviors as appropriate objectives for DMP teachers, and the inservice program was designed to help teachers achieve these objectives.

The objectives listed in Appendix A present a description of what the teacher does when implementing an activity approach to learning mathematics using the DMP instructional program. Specifying the desired outcomes of teacher training programs in terms of behavioral objectives or teacher competencies has become a well-established procedure in recent years. For example, the AAAS Commission on Science Education (1970) has presented its guidelines for the preparation of elementary school science teachers in terms of performance objectives, and the Commission on Pre-Service Teacher Education of the National Council of Teachers of Mathematics (1972) is now in the process of preparing a similar set of guidelines in mathematics.

Describing objectives for the inservice program in terms of specific competencies or behaviors does not imply that mathematics teaching is viewed as only a mechanical skill; teaching is far too complex for that. But just as an artist needs to learn the techniques upon which he builds his artistry, so does the teacher need competence in the techniques involved in skillful teaching. And once the objectives for a program are specified, they can be used to assess the effectiveness of the inservice training.

The Questions of the Study and Their Significance

The effectiveness of the inservice program can be determined in several different ways. One way is to evaluate the teachers' performance on each objective of the inservice program. Thus the first question which this study was designed to answer can be expressed as follows:

> Question 1: What proportion of the teachers achieve each objective of the inservice program?

The importance of Question 1 is that it will identify areas of the inservice program that need to be improved, providing formative data on the success of the training. This type of formative evaluation is a crucial step in the development of any new educational product for use in schools (Scriven, 1967), and its importance in mathematics education is well established (Begle & Wilson, 1970). Since in this case the product is an inservice program that is an essential part of the national installation of the DMP elementary mathematics curriculum, the careful evaluation of the materials and procedures used in the inservice program is particularly important. Also, the degree of success of the inservice training procedures used in this study will also suggest possible improvements that might be made in other inservice programs for mathematics teachers in elementary schools.

Another way to evaluate the effectiveness of the inservice program is to determine the number of teachers whose overall performance demonstrates that they have satisfactorily implemented an activity approach in their classrooms. In this case teacher performance on a set of objectives rather than on a single objective, as in Question 1, was used to provide a more global measure of the inservice program's effectiveness. Thus the second major question of the study is the following:

> Question 2: What proportion of the teachers in the study implement an activity approach to learning mathematics?

The criteria used to determine whether a teacher was doing an adequate job of implementing an activity approach to learning mathematics were chosen on the basis of the results from the pilot study;

the details are reported in Chapter 4, along with the pilot study data.

Question 2 is important for several reasons. First, it provides another means of evaluating the inservice program in terms of a more global measure of teacher performance, this time on a set of objectives that are essential for implementing an activity approach. Second, in answering this question, it will be possible to determine the characteristics of teachers who fail to implement DMP's activity approach; if there are groups of teachers for whom the inservice program is not adequate, then special training could be developed for those teachers. In addition, after identifying a teacher who did not implement an activity approach, the data on the students of that teacher can be treated separately in the assessment of the effectiveness of DMP. This procedure eliminates the problem of including students in the field test of DMP when their teacher did not use DMP materials in the manner intended.

A third question to be investigated by this study is the following:

> Question 3: What are the characteristics of the teachers who fail to implement an activity approach in their classroom, and are these characteristics similar to or different from the identifying

features of non-adopters of
other innovations?

Considerable research has been done on the adoption of innovative practices in agriculture, medicine, and other fields, and attempts are now being made to relate this research to educational change. In this study the characteristics of non-adopters will be investigated to see if the findings agree with the results of earlier research on change in education and other fields. This information is of theoretical interest to social psychologists and others who study the process of change, and of practical interest to mathematicians and educators who are disseminating innovative programs like DMP.

By answering these three questions, the study can determine the effectiveness of a set of procedures for an inservice program designed to help teachers develop certain competencies, specifically those competencies that teachers use in implementing an activity approach to learning mathematics.

In the next chapter the research literature related to the study is discussed. Chapter 3 describes the design of the study, and Chapter 4 presents the results of pilot tryouts of the inservice program and data-gathering procedures. Chapter 5 reports the conduct of the study, and the data on the teachers' performance are summarized in Chapter 6. The conclusions of the study are stated in Chapter 7, along with recommendations for future research.

Chapter 2

THEORETICAL BACKGROUND AND RELATED RESEARCH

There are two main areas of theory and research related to the problem of helping teachers implement an activity approach to learning mathematics. First, this study fits into the framework of teacher education theory and research, since it deals with helping teachers develop the competencies related to an activity approach. Also, in order for teachers to demonstrate these competencies, they may need to change not only their own behavior, but also the organization and management of their classrooms and the system of social norms in the school as well. Therefore, this research also fits into the theory of planned educational change. This chapter will discuss the related research from each of these two areas.

This review of the literature will begin with some general background on the research in teacher education that provides the main setting for the study. Then the particular investigations that are directly related to this one will be described. Similarly, the discussion of the research on planned educational change will proceed from the general problem of implementing educational change to the few studies that deal specifically with helping teachers implement new instructional ideas in the classroom.

Teacher Education Theory and Research

In recent years considerable interest has developed in the use of theoretical models and a systems approach to teacher education. A major effort in this area has been the USOE-funded model teacher education programs (Clarke, 1971). The model inservice program proposed by Harvey (in press) is an extension of that same approach applied specifically to the inservice that is needed to help schools implement new educational programs.

These theoretical models include several important components that represent changes from past practice in teacher education. These changes include the specifications of performance objectives for the teachers, the provision of various types of simulated and real classroom experiences, and the evaluation of the teachers' achievement of the specified objectives. These changes have had a beneficial effect on research in teacher education. For example, the technique of specifying performance objectives, evaluating teachers on their achievement of those objectives, and then measuring how student learning is affected by those teacher behaviors has proven to be a fruitful research area (Rosenshine & Furst, 1971). This type of research has provided far better results than previous attempts to relate teacher personality or attitude to student learning.

While considerable research has been done on inservice training for teachers of elementary school mathematics, these studies have concentrated on the mathematical achievement and attitudes of teachers rather than on the behavior of teachers in classrooms (Ashlock & Herman, 1970). However, attempts to relate teacher achievement and attitude to the achievement of students have not been successful. Fey (1969) reports a number of recent studies of elementary school teachers that have shown no important relationship between teacher characteristics (such as mathematical achievement or attitudes) and teacher effectiveness (measured by student achievement). This type of research has not revealed any important relationships in any subject matter area, or at any grade level (Flanders, 1969; Travers, 1971; Rosenshine & Furst, 1971). The lack of important results in this area has led researchers to suggest that the effectivenesss of an inservice program should be judged on the basis of the classroom behavior of teachers, not their scores on tests of achievement or attitude.

One type of teacher-education research that has focused on teacher behavior is the technical skills approach to teacher training (Berliner, 1969). This approach is the basis for the microteaching techniques developed at Stanford (Allen & Ryan, 1969) and the minicourses for teachers produced by the Far West Laboratory for Educational Research and Development (Borg, Kelley, Langer & Gall, 1970). Research in this area has investigated such topics as the effectiveness of videotape in microteaching as a source of information and feedback for improving questioning behaviors, tutoring techniques, and teacher effectiveness in explaining. Generally this use of videotape has resulted in improvement, and is efficient in using the participant's time; but more traditional methods of presenting information seem to be just as effective in many cases, and considerably cheaper (Berliner, 1969).

While microteaching with videotape has been comparatively successful, it has been developed and used mostly with secondary school teachers. The implications for elementary school teachers are not entirely clear, and at least one attempt to replicate the effectiveness of microteaching on this level was unsuccessful (Kallenbach & Gall, 1969). However, an inservice program using microteaching methods in order to improve mathematics tutoring in the elementary school claimed substantial success (Gall, Dunning, & Galassie, 1970). Again in this study, it was found that using videotape was no more effective than providing feedback by other means, in this case, audio tapes (Dunning & Gall, 1971). Similar results were reported in another study (Gall, Dunning, Banks & Galassi, 1972) where written transcripts of the videotapes were found to be as effective as the videotapes themselves in improving teacher questioning techniques.

The research on microteaching indicates that particular technological advances, such as videotape, may be useful, though not essential, for improving teacher education. But the identification of specific teacher competencies (or technical skills) that teachers can develop and use to increase their students' learning does appear to be a promising approach to take in improving mathematics teaching.

Research on Inservice Programs

While there have been a number of studies of inservice programs in elementary mathematics, they have considered only changes in achievement and attitude; no research has been found that deals with helping teachers develop the particular competencies involved in implementing a new elementary mathematics program. However, there is some related research in other subject-matter areas of the elementary school.

In the area of elementary science programs, Ashley (1967) studied the effect of inservice training on the teachers of the AAAS program *Science--A Process Approach*. The inservice program consisted of eleven meetings over a period of six months. This program, however, did not appear to cause an increase in the desired teacher behaviors. Moreover, there was a negative correlation between the teachers' implementation of desired strategies and positive teacher attitudes toward the program. The reasons for these rather unusual developments are not clear, but it seems likely that one of the main difficulties was the quality of the instruments used. For example, the observation schedule used a number of rather vaguely worded items, such as "Teacher recognizes the limitations of one experiment for the understanding of all students." This would be a very difficult behavior to observe.

A similar research study was conducted using teachers who attended a three-week inservice workshop dealing with the Science Curriculum Improvement Study materials (Bruce, 1970). Again, measures of teacher attitude and personality did not appear to be related to the teachers' performance in the classroom; however, analysis of the teachers' verbal behavior did show that they were using more high-level questions after the inservice workshop. Thomson & Voelker (1970) report replications of this change in questioning behavior by other teachers of new elementary science programs.

Askov (1970) reported considerable success in helping teachers implement an individualized reading program. The inservice training consisted of a series of six meetings held during the school year. Askov found that teachers changed their classroom management procedures by providing a variety of instructional materials and by teaching children in groups of differing sizes. And in a pilot study of a training program on teachers' classroom management procedures, Leinhardt (1971) was successful in developing certain skills expected of nursery and kindergarten teachers who attended a workshop of the Primary Education Project from the Learning Research and Development Center in Pittsburgh.

These investigations of the effectiveness of inservice training programs indicate that teacher behavior can be changed, but they provide little guidance as to what kinds of inservice programs might be most successful. More information on this point is provided by the research on planned educational change.

Theory and Research on Planned Educational Change

The literature on planned change is wide in scope and vast in quantity. Havelock (1969) reviewed approximately 4000 sources in his analysis of the theoretical concepts and the research evidence dealing with change in education, agriculture, medicine, and other fields. This section of the report will discuss the major theoretical perspectives on change, the specific research studies that deal with helping teachers change their behavior, and the implications of this research for inservice programs.

The many theoretical models of the change process in education range from the research-development-diffusion perspective, associated particularly with Guba (1968), to what Havelock (1969) calls the human relations tradition of planned change, with its emphasis on group dynamics. These models vary considerably, but they all deal with the same basic elements that are involved in educational change--the client system (teachers, in the present study), the social structure of the school, the change agent and his relationship to the teachers, and the characteristics of the innovation itself. In the study reported in this paper the focus is on teachers and their relationship to educational change. (For a more complete discussion of the various theoretical perspectives on planned educational change and their relationship to implementing an activity approach to mathematics in elementary schools, see Romberg, McLeod, & Montgomery, 1971.)

The research on change which is most closely related to this study deals with the characteristics of innovative teachers and with the difficulty of helping teachers change. On the basis of research in a number of fields, Rogers (1965) predicted that innovative teachers would be younger, more educated, more cosmopolitan, and more likely to be viewed by other teachers as nonconformists. So far, however, no definite relation has been shown to exist between innovative teaching and the teacher's age (ERIC, 1970). No research has been found that focuses on the relationship between innovative teaching and the teacher's education or cosmopolitan qualities.

A number of studies have investigated the difficulties of helping teachers change their classroom practices. The most extensive of these studies, reported by Goodlad, Klein, and Associates (1970), deals with 158 classrooms in 67 urban elementary schools in 13 states. They investigated the teachers' implementation of new ideas in several areas, including the use of objectives, inquiry teaching, individualization, group dynamics, and modern mathematics programs.

The findings were uniformly negative. In spite of the fact that teachers often said they were individualizing instruction or using inquiry methods, for example, observers did not see these practices being implemented in the classroom. Instead, what the observers saw consisted of teachers "covering material" rather than teaching toward specific objectives, teachers telling students the answers rather than using inquiry methods, teachers conducting class in large groups with almost no individualized instruction, and teachers controlling all student interaction, with no opportunity for small group work--in fact, student interaction was largely discouraged. There was some evidence of curriculum change, particularly in mathematics; but in spite of the emphasis on new content in the mathematics being taught, the old teaching practices still prevailed. This study indicates that teachers are not implementing new ideas in their classrooms, even when they seem to believe that they are; this fact underlines the important role that inservice training must play in helping teachers change their practices. These teachers, incidentally, came from schools that are similar to most of those involved in the present study.

Another study of educational change in the elementary school has been reported by Gross (1969). In this study of an experimental school, teachers were asked to change their role to make it more non-directive. The teachers, administrators and the community were all in favor of this change initially, and yet it was a complete failure within six months. By that time most of the teachers had given up even trying to implement the innovative techniques. Gross believes that the main reason for this was the lack of continued support and training for the teachers during the early stages of implementing the innovation, and recommends that inservice training be continued during at least the first few months of an implementation program that wants to change teacher behavior.

In another study of educationl change, Carlson (1965) reported that the teacher's "need to perform" in the role of lecturer often caused inappropriate use of programmed instruction. Rather than letting children proceed at their own pace, teachers tried to slow down the faster students and speed up the others, apparently so that the students could be taught in a large group, thus satisfying the teacher's need to perform. Again in this case there was no substantial inservice training program and the innovation was not implemented successfully.

Other studies of change at the secondary level have also indicated the difficulties involved in changing teacher performance. Herron (1971), for example, found that teachers of new secondary school science programs were not adequately prepared to explain the point of view of the material they were using. And in a Swedish study of Dahllöf, Lundgren, and Siöö (1971), secondary school teachers, who were supposed to give students additional opportunities for interesting independent study projects, instead provided only additional homework.

In all of these studies of educational change, it appears that inservice training would be a reasonable way to improve the chances for success of an innovation. Also, when the innovation is a complex one involving substantial change in the behavior patterns of teachers, the inservice program should continue for several months after the teachers start using the innovation. This makes it possible for the inservice program to deal with the difficulties that teachers have as they attempt to adapt their teaching to the requirements of the innovation.

The research results summarized in this chapter were used in planning the inservice program designed to help teachers implement DMP's activity approach to learning mathematics. A description of the inservice program is included in the next chapter.

Chapter 3

THE DESIGN OF THE STUDY

As an investigation of the effectiveness of an inservice program for mathematics teachers, the study reported here can be classified as decision-oriented or development-oriented research (Cronbach & Suppes, 1969); that is, the study was designed to answer specific, practical questions about how well the inservice program achieved the objectives set for it, rather than being designed to provide general conclusions about the effectiveness of various types of inservice training. Since this is a practical study of teacher performance, the setting of the study is in schools, not in a laboratory, and the study has been designed to fit unobtrusively within that school setting. This chapter describes the setting and design of the study, the inservice program, and the instruments and procedures used in evaluating that inservice program.

The Setting of the Study

The study was carried out in connection with the 1971-72 small-scale field test for the kindergarten and first grade levels of *Developing Mathematical Processes* (DMP). The small-scale field test is an intermediate stage of the developmental sequence for DMP (Harvey, Romberg, & Fletcher, 1969), following the initial tryouts of the pilot development stage and preceding large-scale field testing and commercial publication. The purpose of the field tests is to determine the effectiveness of the DMP program in a variety of settings. Schools that participate in field testing normally vary on a number of dimensions; they may be urban, suburban, or rural, for example. Also, schools may follow the traditional organizational pattern of self-contained classrooms, or they may be multiunit schools associated with the Wisconsin Research and Development Center's program of Individually Guided Education (Klausmeier, Quilling, Sorenson, Way, & Glasrud, 1971).

The organizational pattern of multiunit schools is illustrated in Figure 1. These schools are organized into units of about 150 students, where each unit is taught by a team of teachers and aides. The number of students in the unit and the planning time made available to the teachers are key factors that enable the staff of the unit to work together in providing individually guided instruction. For example, teachers can identify groups of students with similar needs, and then plan different instruction for different groups of students according to the needs of each group. The DMP materials, while appropriate for self-contained classrooms, are designed to make particular use of the capabilities of the multiunit schools. Similarly, the inservice program and evaluation procedures of the present study were designed for all the teachers in the field test,

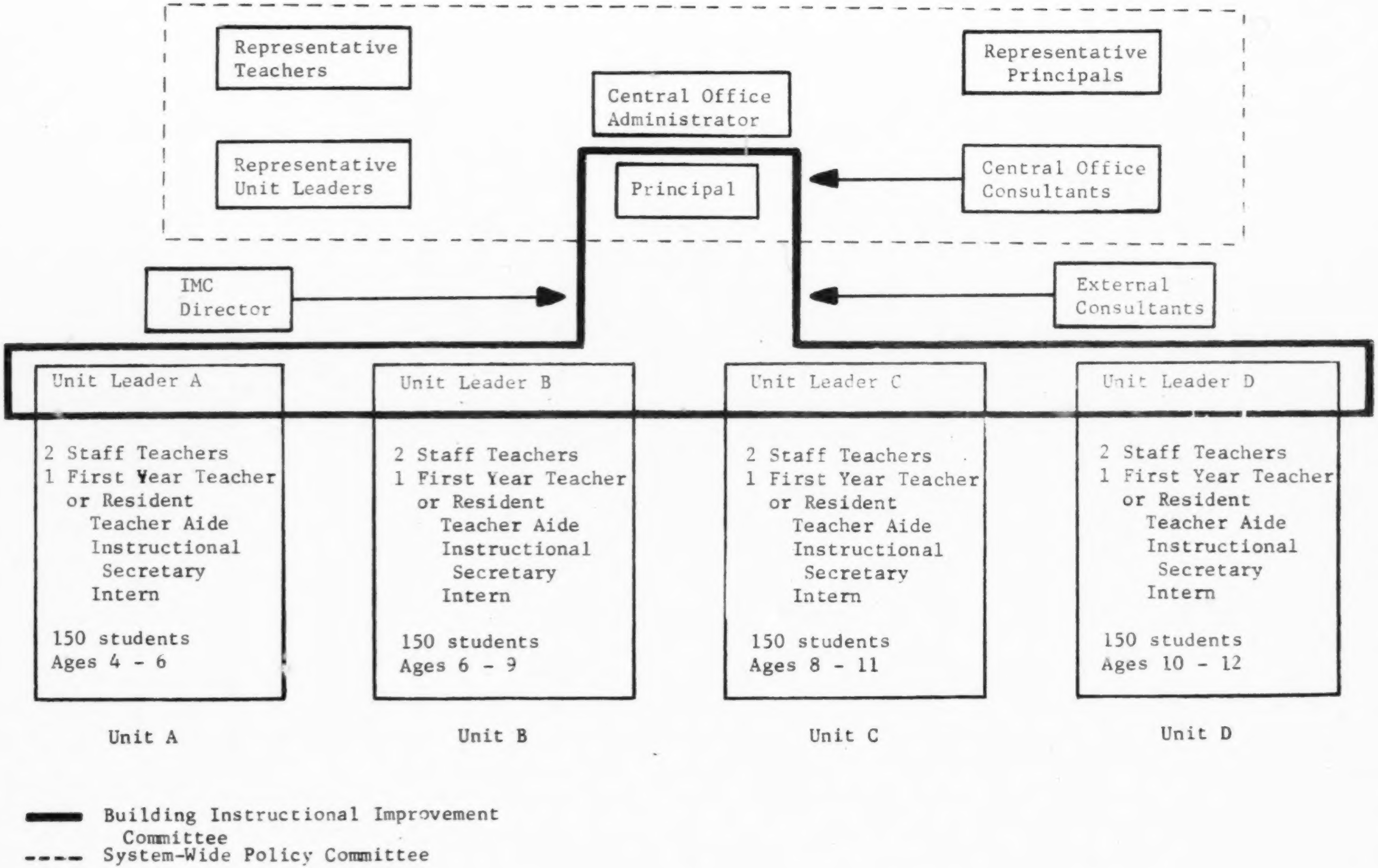
Representative Teachers
Representative Unit Leaders
Central Office Administrator
Principal
Representative Principals
Central Office Consultants
IMC Director
External Consultants
Unit Leader A
2 Staff Teachers
1 First Year Teacher or Resident
Teacher Aide
Instructional Secretary
Intern
150 students
Ages 4 - 6
Unit A
Unit Leader B
2 Staff Teachers
1 First Year Teacher or Resident
Teacher Aide
Instructional Secretary
Intern
150 students
Ages 6 - 9
Unit B
Unit Leader C
2 Staff Teachers
1 First Year Teacher or Resident
Teacher Aide
Instructional Secretary
Intern
150 students
Ages 8 - 11
Unit C
Unit Leader D
2 Staff Teachers
1 First Year Teacher or Resident
Teacher Aide
Instructional Secretary
Intern
150 students
Ages 10 - 12
Unit D
Building Instructional Improvement Committee
System-Wide Policy Committee

Figure 1. A Sample Organizational Chart of a Multiunit School

although it was recognized that teachers in multiunit schools would have some advantages in achieving certain objectives of the inservice program.

When teachers agreed to participate in the field test, they knew that they would receive DMP materials and inservice training. They were also informed of regular field test procedures for gathering data. For example, teachers were asked to cooperate with the field test staff by providing information on students' reactions to the materials, on the teacher's own reactions to the materials, and on ways to improve the materials. In addition, the teacher knew that observers would visit DMP classrooms to gather more information on the children's responses to the materials and on how DMP could be improved.

The evaluation of the inservice program was designed to be an integral part of the field test; that is, the information gathered from teachers was to be obtained as a part of the regular field test procedures. Data were to be collected in a variety of ways. First, classroom observations of teachers would be carried out as a part of the observations of children's reactions to DMP. Second, teachers would be given questionnaires that asked them to report on how they had used the materials and on their recommendations for improving the materials. Third, since a random sample of DMP classrooms was chosen for the purpose of gathering data on a sample of students in the field test, the teachers of these students would be interviewed briefly with regard to their own records of student performance.

All of these data to be gathered unobtrusively; the observation procedures were designed so that teachers would not feel that they were being evaluated. Rather, the teachers were to be actively involved in evaluating DMP materials and the inservice program. The design called for teachers to be treated as colleagues whose opinions were valued, not as subjects in an experiment. The next section of the report presents an overview of the design of the study.

The Elements of the Design

The main elements of the design of the study, the inservice program and the evaluation procedures, are outlined in Figure 2. The inservice program was designed to be carried out in a two-day workshop (W) before the start of school, followed by four one-hour inservice meetings (IM) during the first eight weeks of school. After these four meetings, field test meetings (FTM) were to be held about every two weeks until mid-January; these meetings were planned to be shorter, lasting about half an hour. The main purpose of the field test meetings was to obtain responses from the teachers about the materials, rather than dealing with inservice topics. The details of the design of the inservice program, along with a rationale for its development, are reported in the next section of this chapter.

MONTH	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY
INSERVICE	W	IM	IM IM	IM FTM	FTM	FTM	
EVALUATION		V	V V	O O	I O	O	Q I

Code:
W Inservice Workshop
IM Inservice Meeting
FTM Field Test Meeting
V Classroom Visitation
O Classroom Observation
Q Questionnaires
I Interviews

Figure 2. The Main Elements of the Design

The other main part of the design represented in Figure 2 is the evaluation procedures--classroom observations, questionnaires, and interviews. The observations were to be carried out by the same persons who conducted the inservice meetings and the field test meetings. During the first three classroom visitations (V), the observers were to gather information on the students' reactions to the materials, but not on teacher behavior. The data on teacher performance were to be obtained after the inservice program was complete and the teachers were accustomed to having the observers in the room. The presence of an observer usually tends to cause teachers to change their behavior, but the effect of the observer on the teacher normally decreases with each visit (Jackson, 1965; Webb, Campbell, Schwartz, & Sechrist, 1966). In the present study it was expected that the effect of the observers on the teacher would be insignificant no later than the third visit.

After the first three visits, the design calls for classroom observations of teacher behavior (O). The four days of observations were scheduled about every two weeks (with a break for Christmas vacation) from November to January, from the time the inservice meetings ended until the conclusion of the first semester. More detail on how these observations were carried out is included in the section on evaluation procedures later in this chapter.

In addition to the observations, three questionnaires (Q) were to be administered to all of the teachers at the end of the first semester. These questionnaires asked the teachers about their teaching practices, their knowledge and opinions of the program, and their educational background. In addition, some information on the teachers' use of DMP materials was to be obtained through interviews (I) with teachers from a random sample of field-test classrooms.

As indicated in Figure 2, the time span covered by the study was about one semester, with the first half spent primarily in inservice training, and the second half in the evaluation of the effectiveness of the training. Half of a semester was decided upon as a reasonable length of time for teachers to adapt their teaching strategies to DMP's activity approach to mathematics. If a teacher had not adopted the behaviors involved in an activity approach by the second half of the semester, then the inservice program would be considered inadequate for that teacher. The criteria for determining the adequacy of a teacher's performance were based on data from the pilot study; these criteria are described in Chapter 4.

In addition to the base-line data generated from the pilot study, it would have been useful to have obtained "pretest" data by observing the teachers in their own classrooms during the year before they started using DMP. However, since the teachers and schools that participated in the field test were not selected until the summer of 1971, no pretest was possible. Instead, it was decided to ask teachers (Questionnaire C) how their teaching practices had changed since the previous year; Chapter 6 will summarize the responses of the participants in the study. Another way to compensate for the lack of a pretest is to use the data that other studies have reported on teaching practices that are common in schools similar to those involved in this study (Goodlad, Klein, & Associates, 1970); while these data do not allow us to make meaningful statistical comparisons between groups of teachers, they provide useful background information for making practical decisions about the effectiveness of the inservice program.

This section of the report has presented an overview of the design of the study. The chapter continues with a more detailed discussion of the main elements of the design--the inservice program and the evaluation procedures.

The Inservice Program

The purpose of the inservice program is to help teachers implement an activity approach to learning mathematics. The specific competencies that teachers need in order to implement an activity approach with DMP materials are found in Appendix B; these competencies are stated as behavioral objectives for DMP teachers and were used in designing and evaluating the inservice program. These objectives were specified by the developers of DMP as being important for the appropriate implementation of DMP's activity approach to learning mathematics.

The design of the inservice training follows the recommendations for a model inservice program proposed by Harvey (in press). The main components of the model include (1) providing teachers with information about the content to be taught and the techniques to be used, (2) providing for simulation of an activity approach as a part of the inservice training, and (3) continuing the inservice program through the initial period of the classroom implementation. The first two components of the model were to be included in a workshop for teachers conducted before the beginning of school, while the third component was to be carried out through the series of inservice meetings planned for the first semester after the inservice workshop. By beginning an inservice program with a workshop, teachers are provided with the knowledge of the new materials and procedures that appears to be a necessary prerequisite to getting started with an innovative program (Bessent, 1967); the continuing inservice meetings give teachers the support and encouragement that they seem to need during the first few months of implementing new ideas in the classroom (Gross, 1969).

The inservice workshop. A great deal has been written about ways to improve inservice education (for example, Rubin, 1971), but there is little research evidence to guide the development of inservice workshops, as was seen in Chapter 2. Therefore, each developer needs to determine how best to design an inservice workshop in terms of his objectives. In the present study, the design of the inservice workshop was guided by the objectives for DMP teachers listed in Appendix B.

The basic strategy for the workshop was first to have teachers participate in a simulated activity-approach classroom; then, after arousing the teachers' interest in an activity approach, the workshop would continue with a more thorough examination of what a teacher needs to know and to do in order to implement DMP and its activity approach to learning mathematics. Therefore, it was planned that the inservice workshop would begin with a mathematical activity for teachers that introduced them to an activity approach (see the sample agenda in Figure 3). Two activities were chosen to be used in the inservice workshop; they are included in Appendix C. These activities were selected primarily because they would provide an opportunity for the workshop leader to illustrate many of the behaviors related to an activity approach, and give the teachers a model on which to base their own behavior. This modeling procedure is believe to be an effective way to change teacher performance (Berliner, 1969). During the activity the teachers would be asked to solve problems while working in small groups, to make hypotheses, and to validate their hypotheses. Empirical validation would be emphasized, while validation by authority would be discouraged. The activity would conclude

AGENDA

Inservice Workshop for DMP Teachers

Day 1	Topic
9:00 - 10:30	An Activity Approach to Math
10:30 - 12:00	Overview of DMP Materials
12:00 - 1:00	Lunch
1:00 - 1:30	Mathematical Processes in DMP
1:30 - 2:30	The Mathematics Included in DMP
2:30 - 3:00	Field Testing R and D Center Materials

Day 2	
9:00 - 10:30	Using DMP Activities
10:30 - 12:00	DMP Assessment Materials
12:00 - 1:00	Lunch
1:00 - 2:00	"Using a Mathematics Laboratory Approach"-- Film and Discussion
2:00 - 3:00	Planning Time

Figure 3. A Sample Agenda from a Summer Workshop

by having each group present a display of their findings and by discussing which of the hypotheses appeared to be correct and which did not. After the activity, the procedures that make up an activity approach would be discussed with particular reference to the activity just completed by the teachers. Thus the workshop would begin with both an illustration and a discussion of the desired teacher behaviors involved in structuring an activity (Objectives 3-6), in interacting with students (Objectives 7-10), and in organizing the classroom (Objectives 11-15).

The plan for the workshop continues with an overview of the instructional and assessment materials used in DMP; these materials include manipulatives, printed matter for teachers and children, pupil performance records, and assessment instruments. The discussion of the materials was designed to help teachers see how they could provide an activity approach to learning mathematics in their classroom through the use of DMP instructional activities (Objectives 1-2) and assessment procedures (Objectives 18-24). It was planned that the overview of DMP materials would be followed by a detailed discussion of the mathematical processes emphasized by DMP and a description of the geometry and arithmetic topics that make up the first two levels of DMP (Objectives 16-17).

The first day of the workshop would conclude with a discussion of the field test purposes and procedures. The teachers were to be informed of the continuing sequence of tryouts and revisions of DMP materials in which they were now to play an active role, and the field test staff would outline the data-gathering procedures, including the classroom visits to observe students as they worked with DMP materials and the testing program that would be used to determine the students' achievement in mathematics.

The workshop's second day was to begin with a more detailed look at DMP instructional activities--their organization, objectives, and sequencings--and the related assessment procedures, such as placement and achievement tests. During this time the teachers could be shown how the instructional and assessment materials would fit together in a specific activity. The activity included in this part of the workshop was chosen to illustrate important mathematical processes (Objective 17) and a variety of assessment procedures (Objectives 18-24).

The workshop would continue with "Using a Mathematics Laboratory Approach," a film produced by the Project for Interpreting Mathematics Education Research of Pennsylvania State University. The film reviews some of the research on the effectiveness of certain aspects of an activity approach, and illustrates some of the procedures, such as the use of manipulative materials by children working in small groups. The discussion of the film and its relationship to DMP's activity approach was to be followed by a short planning period when teachers could ask questions and begin preparing for their first day's instruction using DMP. Thus the inservice workshop would conclude with a time for answering individual questions from teachers on how to implement an activity approach.

The inservice meetings. As indicated in Figure 2, the inservice meetings were to be held approximately every two weeks during the first two months of the school year. The schedule of inservice meetings follows the recommendations of Gross (1969) for continuing the inservice program through the initial implementation period. The topics discussed during these meetings, which are listed in Figure 4, reviewed and expanded on ideas presented during the initial workshop. The topics were sequenced as indicated in Figure 4 in order to help teachers with the problems of initiating an activity approach (Meeting 1) and DMP assessment procedures (Meeting 2) before attempting to refine the teachers' conception of an activity approach (Meeting 3) and their knowledge of the mathematics in DMP (Meeting 4).

The first meeting was designed to help teachers with the problems of getting an activity approach started in their classroom. The discussion would center on choosing, organizing, and preparing for activities, and would give teachers a chance to share problems and exchange possible solutions. The second meeting would extend the discussion of the assessment materials that was begun in the

Inservice Meeting Topic	Date
Meeting 1: Managing an Activity Approach Choosing activities Organizing an activity Preparing materials	Mid-September
Meeting 2: DMP Assessment Procedures Instruments Records of student achievement Providing individually guided education	Early October
Meeting 3: "An Activity Approach to Math" Discussion of the pamphlet Suggestions for improving the pamphlet	Mid-October
Meeting 4: "Mathematical Processes" Discussion of the pamphlet Suggestions for improving the pamphlet	Early November

Figure 4. The Schedule of Inservice Meetings

workshop and would emphasize ways that the teachers could use the assessment information that they would be gathering. The focus for the third and fourth meetings was provided by two pamphlets for DMP teachers, "An Activity Approach to Math" and "Mathematical Processes." In each meeting one of the pamphlets would be discussed and teachers would be asked to suggest ways to improve the pamphlets.

The plan for each meeting also included a time for teachers to ask questions and to suggest revisions in DMP materials. In addition, teachers were to be encouraged to share information on techniques or activities that had been particularly successful, or unsuccessful, so that they could learn from each other's experiences. At every meeting, an attempt would be made to provide an atmosphere of support and encouragement for the teachers; they would never be criticized. Rather, the intent was that the positive atmosphere would strengthen the group norms of the set of participating teachers in each school, thus supporting the teachers as they changed their behavior in order to implement an activity approach to learning mathematics.

It was anticipated that some changes would be needed to adapt the inservice program to the needs and schedules of the particular schools involved in the study. Thus a pilot study of the inservice program was undertaken. The results of the pilot study and its effect on the inservice program for the main study are reported in the next chapter. The details of the conduct of the inservice program of the main study are described in Chapter 5. The next section discusses the other main element of the design--the evaluation procedures.

The Evaluation Procedures

As indicated earlier in this report, a substantial amount of research has shown that teacher characteristics do not seem to be related to teacher effectiveness, but certain teacher behaviors apparently are. To put it another way, the crucial point in teaching mathematics in the elementary school seems to be what the teacher does, not just how much the teacher knows. Similarly, in a study of teacher training procedures, the main evaluation technique should be classroom observation of what the teacher does, not just questionnaires that measure what the teacher knows.

While observation was the basic technique for gathering data in this study, questionnaires and interviews were also to be utilized, following the recommendation that multiple measurements of phenomena should be used where possible (Webb, Campbell, Schwartz, & Sechrist, 1966). This section of the chapter will discuss the evaluation procedures--observations, questionnaires, and interviews; the related instruments are included in Appendix B.

The observation schedule. The main technique to be used for evaluating the effectiveness of the inservice program was classroom observation of teacher performance. Many instruments have been developed to analyze classroom behavior; Simon and Boyer (1967) have collected 17 volumes of them, and new or refined instruments are continually being developed for special purposes (Resnick, 1971; Reynolds, Abraham, & Nelson, 1971). However, none of these instruments was appropriate for this study, for two main reasons. First, no instrument was found that assessed most of the behaviors involved in implementing an activity approach, and second, most instruments were designed to be used by an observer who was clearly recording teacher behavior. Such instruments were not appropriate for this study with its requirement for unobtrusive measures. Therefore, it was necessary to construct and try out an observation schedule for this study.

Following the recommendations of Medley and Mitzel (1963) and in line with the needs of the study, an observation schedule was developed using a "sign system"--that is, only certain behavior is recorded--as opposed to a "category system," where all behavior is classified into a few mutually exclusive categories. As many as possible of the teacher behaviors related to an activity approach were included in the observation schedule. Those behaviors that were not normally observable in the classroom were assessed by questionnaire or interview.

In addition to recording the occurrence of certain behaviors, the observation schedule also describes the context in which the behavior took place, including the activity, its purposes, and the point (opening, middle or closing) at which the observation occurred. While many classroom observation systems do not take it into account, the importance of the context of particular behaviors is now being recognized (Nelson, Reynolds, & Abraham, 1971). Whether a specific behavior is appropriate or not often depends on the requirements of the activity in which the teacher is involved. For example, in an activity approach, some lessons call for students to work in a large group under the teacher's direction, while other activities require that the teacher organize the students into small groups.

After recording the teacher's behavior and the context in which the behavior occurred, the observer can judge the appropriateness of the behavior. For example, if the observer notes that the teacher is working with the class as a large group in an activity that called for small groups, the behavior would be recorded and marked inappropriate for that activity. In this way, the observer records teacher behavior and then, considering the context, judges whether or not the teacher has demonstrated the desired behavior.

Observation procedures. As indicated in Figure 2, observers were to be in each school on seven separate days from September to January. The announced purposes of the visits were the same throughout the study; the observers came to see the students as they used

DMP materials and to conduct meetings (inservice meetings or field test meetings) with the teachers. However, during the last four visits the observers also gathered data on teacher behavior. While the observers changed their emphasis from only making notes on student behavior to also recording teacher behavior, they were not to change their actions in the classroom in ways that teachers or children would notice.

Due to financial and time limitations, studies of this type are usually designed to have only one observer in a school on a given day. Since up to three or four teachers at the same grade level may teach mathematics at the same time, one observer could not be present for all of each class. Therefore, it was necessary to decide between sampling teachers or sampling time.

The alternative of observing a sample of teachers was rejected; for the purposes of this study, it was deemed more important to have information on all of the teachers than to have more detailed information on only a few of them. Also, it seemed desirable to give the teachers equal treatment when possible, since past experience with DMP teachers indicated that some of them felt left out if their students were not observed. In addition, it was important to see a teacher on all four observation days, if possible, before making any judgments about the teacher's performance. Therefore, it would not have been desirable to observe one teacher for an entire class because this would have meant that some teachers would have been observed only on one day. Several modifications of these procedures were also considered, but time sampling appeared to be the best alternative for the purposes of this study.

The time-sampling procedure was (1) to spend about five minutes in the classroom to become familiar with the activity and other aspects of the context in which the teacher behaviors occurred, (2) to observe for five minutes the behavior of the teacher, (3) to record unobtrusively the results of the observation, and (4) to repeat the procedure with the next teacher to be observed during that class period. If there was no other teacher to be observed at that time, the procedure was to be repeated with the same teacher.

When there was more than one teacher to be observed during the same class period, the order in which the teachers were observed would be determined at random. The observations would start with a different teacher each day so that the observer would have the opportunity to see each teacher during the opening of at least one activity. Once the cycle was completed and each teacher was observed during the beginning of an activity, a new random order was to be chosen and the observations continued.

The time-sampling procedure has many advantages. It allows the observer to see each teacher on each day, providing a good idea of the different activities being used by the teacher. The five-minute period of observation is long enough so that the teacher can be assessed on the behaviors, and still it is sufficiently brief so that all the teachers can be observed on a given day.

After each observation, the observer was to record whether or not a particular behavior had been demonstrated at least once during that five-minute period. This periodic note-taking by the observer took very little time and was much less noticeable than the other common procedure for classroom observation of tallying the occurrence of teacher behaviors. In addition, Medley and Mitzel (1963) report that the number of times a behavior occurs at least once in a number of five-minute periods is highly correlated with the number of times the behavior occurs over much longer time segments. Thus the procedure of recording the presence or absence of a behavior should be as accurate as, and less obtrusive than, tallying the number of times the behavior occurred.

One other aspect of the observational procedures was an important factor in the design of the study. In order to control for any effect due to differences between the observers, either in terms of their observations or their conduct of the inservice meetings, it was decided that each observer should spend the same amount of time in each school. This balancing was to be carried out by establishing a schedule of visits where the two observers alternated in traveling to each school that participated in the study. A more detailed report of the activities of the observers is found in Chapter 5.

In addition to the classroom observations, data were also to be gathered by questionnaire and by interview. The next section discusses the questionnaires.

The questionnaires. Not all of the behaviors that are related to an activity approach could be assessed by observation. For example, it would be difficult to know if the teachers were keeping records of student achievement (Objective 18) or if they could choose activities designed to teach a particular concept (Objective 21) just by observing their classes. Therefore, Questionnaire A was developed to assess some of the objectives of the inservice program.

While Questionnaire A was developed to assess specific objectives, it also had a broader purpose--to gather all kinds of information from teachers on ways to improve DMP materials. This purpose made the questionnaire a useful way for the teacher to express her views as well as a means of finding out how the teacher performed on certain objectives. Questions about what the teacher had done were included along with requests for ideas on how the materials could be improved.

All of the teachers in the study were to complete Questionnaire A; it was to be administered during the mid-year workshop at the end of January. Questionnaires B and C were also to be given to teachers at the mid-year workshop. Questionnaire B gathered descriptive information on the teachers' background and professional activities, while Questionnaire C assessed teachers' attitudes, opinions, and previous teaching practices. Portions of Questionnaires B and C were based on instruments used for similar purposes in the National Longitudinal Study of Mathematical Abilities conducted by the School Mathematics Study Group (Travers, 1971). Each of the three questionnaires was tried out initially with experienced DMP teachers and revised twice before being used in the study. The questionnaires are included in Appendix B.

Interviews. In addition to data gathered by observation and by questionnaire, it was planned to interview a random sample of teachers in each grade level on the records of student achievement which they kept. The interviews were to be carried out by field test staff as a part of regular field test procedures. These procedures included selecting a random sample of students in December and February in order to monitor student achievement. The teachers of these students were to be asked to provide whatever records of student achievement they had in order to assist the interviewer in assessing the children. The interviewer would then report the type of records that the teacher kept along with the data on student achievement.

Rating teachers on the objectives. It was planned that each teacher in the study would be rated on each of the objectives listed in Appendix B. The ratings to be used were mastery, non-mastery, and inconclusive. The data on which the ratings are based are reported in Appendix D.

The rating of mastery for an objective would be assigned to teachers who demonstrated the desired behavior in 75% of the observations during which the behavior was appropriate. The mastery level of 75% was chosen because it allowed for the possibility that a teacher might have one bad day out of the four days of observation.

When an objective was to be assessed by observation, the teacher had to be observed at least three times before a rating of mastery could be assigned. Teachers who were observed not more than twice would be given non-mastery or inconclusive ratings, depending on their performance up to that point. This procedure was adopted to insure that the performance of the teachers would be more likely to be underrated than overrated, thus preventing any overestimation of the effectiveness of the inservice training due to a lack of observations.

Responses on Questionnaire A that were related to objectives were also given ratings of mastery, non-mastery, and inconclusive (when there was no response). For objectives that were assessed by more than one procedure, the source of information that was believed to be most reliable received the most weight in making the rating. The details of what constituted mastery in each of these situations is described in Chapter 6 along with the data on teacher performance.

Once the teachers have been rated on each objective, the two most important questions of the study can be answered. These questions, stated originally in Chapter 1, are as follows:

> Question 1: What proportion of the teachers achieve each objective of the inservice program?
>
> Question 2: What proportion of the teachers in the study implement an activity approach to learning mathematics?

In order to determine what proportion of the teachers should achieve each objective in order for the inservice program to be considered successful, performance criteria needed to be set. The ratings of the teachers could then be compared to the specified criteria in order to evaluate the effectiveness of the inservice program. Rather than setting arbitrary criterion levels for adequate achievement of each objective (Question 1) and for adequate implementation of an activity approach (Question 2), a pilot study of the evaluation procedures was carried out with experienced DMP teachers. The results of the pilot study were used in setting appropriate performance levels for the teachers in the main study. The pilot study and the performance criteria generated from it are reported in the next chapter.

Chapter 4

THE PILOT STUDIES

Before this study was conducted, the main elements of the design, the inservice program and the evaluation procedures, were tried out with teachers. The circumstances of the tryouts varied considerably; the observation schedule, for example, underwent extensive pilot testing over a period of approximately two months, while some portions of the inservice program were tried out only briefly. This chapter reports the tryouts of both the inservice program and the evaluation procedures, and concludes with a description of how the data gathered in the pilot studies influenced the setting of the performance criteria that were used in the main study.

Tryouts of Components of the Inservice Program

The inservice program was made up of two main parts--the workshop for teachers at the beginning of the school year and the series of inservice meetings during the first semester. The first part of every workshop was always an activity for teachers; its purpose was to illustrate an activity approach to learning mathematics. Two of these activities were tried out with teachers and others who attended an informational meeting on DMP during March, 1971. While most of the participants were teachers, a substantial minority were administrators, including superintendents, curriculum specialists, and principals. The meeting lasted for about an hour and a half, and over two-thirds of that time was spent working on the activities and then discussing them.

Participants were asked to evaluate the meeting in terms of the value of the information presented and the quality of the presentation; about half of them did. Of the 20 questionnaires received, about 70% said that the information received was useful and that the quality of the presentation was high. While it was not always possible to identify which of the respondents were teachers, it appeared that at least some of the low ratings came from administrators who were more interested in factors such as the cost of materials than in how DMP could be used to implement an activity approach to learning mathematics. Thus the activities were judged to be appropriate for teachers, and, after minor revisions based on the results of the tryout, they were included in the inservice program.

Most of the other parts of the inservice workshop described in the previous chapter were tried out in a one-day workshop for experienced DMP teachers. Informal feedback from the teachers at that workshop resulted in a resequencing of the presentation on DMP assessment, but the other parts of the program received favorable responses from the teachers. The only part of the inservice workshop that was not tried out with teachers in advance was the film.

The other main component of the inservice program, the inservice meetings, has been used by the developers of DMP in various forms for several years. These meetings have usually been rather informal sessions where the writer of the materials provided teachers with whatever help and encouragement they needed, and where the teachers provided the writer with feedback on how the materials should be revised. Experienced DMP teachers were interviewed about the value of these inservice meetings. These teachers stated that regular inservice meetings were very useful in helping teachers to make appropriate use of the materials. The teachers emphasized that DMP and its activity approach are so different from the usual mathematics program that teachers need time, help, and reassurance as they change their teaching practices. The information obtained from the experienced DMP teachers emphasized the importance of the inservice meetings discussed in the previous chapter.

In summary, the tryouts of the various components of the inservice program generally indicated that each component was appropriate for helping teachers implement an activity approach to learning mathematics. On the basis of the tryouts some minor revisions were made in a few of the presentations and materials used in the inservice program. However, no revisions in the basic design of the inservice program appeared to be necessary and the design described in Chapter 3 was carried out in the main study.

The Tryout of the Evaluation Procedures

The evaluation procedures included observations, questionnaires, and interviews. The interviews were to be very brief and informal, and since they were to be carried out by experienced interviewers from the field test staff, no pilot testing was necessary. The questionnaires were tried out with experienced DMP teachers from both multiunit and traditionally organized schools. The responses on the questionnaires and conversations with teachers indicated that some items were not clear, so the questionnaires were revised twice before being used in the main study. But the most extensive of the tryouts involved the observation schedule and the observation procedures.

The observation schedule was initially tried out with eight experienced DMP teachers. The tryout was conducted by the investigator and two associates who became the observers for both the pilot study and the main study. During the tryout, the two observers and the investigator refined the observation schedule and eliminated as many of the ambiguities and disagreements as possible. These disagreements inevitably arise whenever one attempts to describe something as complex as teaching, and they raise the problem of the reliability of procedures for measuring teacher behavior.

Many different techniques have been proposed for estimating the reliability of observation procedures (McGaw, Wardrop, & Bunda, 1972).

The first consideration, and the most important one for the present study, is the percentage of inter-observer agreement. More complicated techniques for estimating reliability using analysis of variance procedures have been proposed, but there is no agreement on their applicability in studies of teacher behavior where the assumptions of the analysis of variance model have not been met (Claus, 1969). Therefore, inter-observer agreement was the means chosen to measure the reliability of the observations.

Inter-observer agreement. After the initial development of the observation schedule, a pretest of inter-observer agreement was conducted before any data were collected for the main study. The percentage of inter-observer agreement was based on the last 20 items in the Observation Schedule (Appendix B); these 20 items involved some amount of observer judgment. Data for the pretest came from 23 observations where the two observers gathered data simultaneously on each of the eight experienced DMP teachers; the observers agreed on 416 items out of 460 for a percentage agreement of 90.4%. The posttest was conducted during the last round of observations at one of the schools involved in the study, and included three observations (60 items). The inter-observer agreement for the posttest was 91.7% (Table 1).

The level of agreement between the two observers compares favorably with that found in other studies of teacher behavior. The high

TABLE 1

INTER-OBSERVER AGREEMENT

Assessment	Number of teachers	Number of observations	Number of agreements	Total number of items	Percent agreement
Pretest	8	23	416	460	90.4%
Posttest	3	3	55	60	91.7%

percentage of agreement resulted from the fact that most of the items on the observation schedule focus on specific behaviors that can be easily identified. The disagreements between judges that did occur tended to come from those items which are labeled in the schedule as "high-inference" (Rosenshine & Furst, 1971). For these items the observer had to make a judgment about a series of events rather than about one specific behavior. In item III.4, for example, the observer had to judge the clarity of the teacher's presentation. While it is difficult to make these high-inference judgments reliably, they are important criteria of teacher effectiveness and deserve to be included in studies of teacher performance.

Data on the performance of successful DMP teachers. As a part of the pilot study of the evaluation procedures, complete data were gathered on the performance of three of the experienced DMP teachers. These three teachers were chosen for several reasons. First, the developers of DMP, who were well acquainted with these teachers, generally agreed that each of them implemented an activity approach in at least a minimally adequate way. Second, since the three teachers varied greatly in their teaching style, they provided an opportunity to test the ability of the evaluation procedures to distinguish between teachers who used different teaching techniques. Third, the teachers represented both kindergarten and first-grade levels. Since the three successful DMP teachers were well-known by the developers of DMP, data gathered on the performance of those teachers could be compared with previous knowledge of their performance, thus providing a useful check on the validity of the evaluation procedures.

Each of the three teachers was observed from seven to thirteen times; the observations occurred on three to five different days. The observation procedures followed in the pilot study were the same as those in the main study--the observers spent the first few days gathering information on student reaction to the materials and later began recording their observations on teacher behavior. Later in the semester, after the observations were completed, the teachers filled out Questionnaire A.

The teachers in the pilot study were assigned mastery, nonmastery, or inconclusive ratings, as outlined in Chapter 3. All three of the teachers received mastery ratings on seventeen of the objectives. Data on the other seven objectives are summarized in Table 2.

Objective 6, which deals with how the teacher closes an activity, was the only objective on which a teacher was assigned an inconclusive rating. During the three days of observations on this teacher, no situation arose in which this particular behavior would have been expected or required. Thus it could not be determined whether this teacher did or did not exhibit this behavior on occasions when it was appropriate.

TABLE 2

RATINGS OF PILOT STUDY TEACHERS ON SEVEN OBJECTIVES

Objective*	Number of teachers rated		
	Mastery	Non-mastery	Inconclusive
6	2	0	1
9	2	1	0
18	1	2	0
20	0	3	0
21	2	1	0
22	2	1	0
24	2	1	0

* These numbers refer to objectives in Appendix A.

Two of the teachers were very skilled at probing student responses (Objective 9), and they encouraged students at every opportunity to validate or justify their mathematical statements. The other teacher demonstrated this behavior during only about half of the observations, and thus received a non-mastery rating.

Objectives 18 and 20, which deal with keeping records of student achievement and using those records to group students for instruction on the basis of achievement, were generally not achieved by the three teachers considered here. These teachers did not attempt to individualize instruction by forming groups of students who needed to work on the same topics (Objective 20); as a result they had less need for detailed records of student achievement (Objective 18), and only one teacher kept such records.

One teacher did not appear to know that each activity in the DMP Teacher's Guide was designed to teach specific objectives (Objective 21); another teacher asked children to sit and wait rather than redirecting them to a new task when they finished an activity (Objective 22). While all of the teachers selected activities in an appropriate sequence, one of them could not identify the various options that DMP teachers are encouraged to exercise in choosing and sequencing activities (Objective 24).

Of the 24 objectives, one teacher demonstrated 23, another 21, and the third 18 of the desired behaviors. These results indicated that the evaluation procedures enabled the observers (who had not known these teachers previously) to make judgments about the teachers' performance that conformed to the opinions of the developers of DMP, who had been associated with these teachers for over a year. While each teacher was implementing an activity approach in an adequate way, the differences among the teachers were identified by the evaluation procedures, and the correspondence between the evaluation results and the opinions of DMP developers provided a useful, though informal, check of the validity of the assessment.

The data on the three successful DMP teachers indicated that the mastery level of 75% (i.e., assigning a mastery rating to a teacher who demonstrated the desired behavior in 75% of the observations where it was appropriate) was useful for differentiating among teachers. Also, the pilot study showed that a teacher could be rated mastery or non-mastery on almost every objective by the end of seven observations; an inconclusive rating was used only once. Reducing the number of observations of these teachers to four or five would have had no effect on the ratings for most objectives; however, for those objectives (4, 6, and 22) which were frequently not observable during the pilot study, a reduction in the number of observations would have resulted in an increased number of inconclusive ratings. But since Objectives 4, 6, and 22 are not the most important of the objectives, and since gathering seven or more observations on each teacher would have involved extra costs in money and time disproportionate to the information gained, it seemed reasonable to obtain four or five observations on each teacher and to expect a somewhat higher occurrence of inconclusive ratings in the main study.

On the basis of the observations made in the pilot study it appeared that a teacher should be observed on at least three different days before a rating of mastery could be assigned. This was a matter of judgment based on the experience gained during the pilot study; a sample of only one or two days of observations seemed too small for assessing teacher behavior. The variety of tasks and instructional procedures used in an activity approach make it particularly important that observations be carried out on more than two days so that a sufficient sample of the various procedures can be observed.

The pilot study of the eight experienced DMP teachers was very useful in verifying that the evaluation procedures outlined in the previous chapter could be applied reliably. In addition, the data collected on the three successful DMP teachers in the pilot study helped to establish the validity of the data gathered in the main study. Therefore, the evaluation procedures were applied in the main study according to the plans of the design. Besides verifying the applicability of the evaluation procedures, the experience gained in the pilot study made it possible to set realistic criteria for judging the success of the inservice program and for determining whether or not a teacher had implemented DMP's activity approach to learning mathematics in at least a minimally adequate way. The next section of the paper will discuss those criteria.

The Performance Criteria

One of the purposes of the pilot study of the evaluation procedures was to gather base-line data on what constituted satisfactory achievement of the objectives of the inservice program. The data on the successful DMP teachers, along with the goals of the developers of DMP, were used in setting desired performance levels or performance criteria for the teachers in the main study. In order to determine the effectiveness of the inservice program, the teachers' performance would be compared to these criteria, not to a control group, and judgments about the inservice program would be based on that comparison.

The performance criteria were determined in relation to the first two questions of the study, as stated in Chapter 1. The first question asked for the proportion of the teachers that would achieve each objective of the inservice program. For the inservice program to be judged a success, it was determined that 90% of the teachers should teach toward the objectives for DMP students (Objective 1), provide the printed and manipulative materials needed for the activities (Objective 2), and demonstrate their own mastery of the objectives for DMP students (Objective 16). These three objectives are the most crucial, and they will be referred to as Category A objectives (Table 3).

Since Category A objectives are so basic to a teacher's implementation of an activity approach to learning mathematics, they were assigned the criterion level of 90%. Every objective not in Category A was assigned the criterion level of 80%. Objectives not in Category A were still considered to be important, but they were judged to be less crucial to an activity approach than the Category A objectives. In summary, a completely successful inservice program would result in 90% of the teachers in the study receiving mastery ratings on each of Objectives 1, 2, and 16 (Category A), and 80% of the teachers achieving mastery of each objective not in Category A (Table 4).

The second question stated in Chapter 1 asked for the proportion of the teachers in the study that would implement an activity approach to learning mathematics. Before this question can be answered, it is first necessary to state the criteria for judging whether a teacher's performance represents adequate implementation of an activity approach. The most important objectives in making this judgment are again those in Category A; a teacher should achieve all three of the objectives in Category A in order for that teacher's performance to be considered satisfactory. In addition, a teacher who implements an activity approach should achieve the objectives in

TABLE 3

OBJECTIVES IN CATEGORIES A AND B

Category	Objective	Abbreviated statement of objective
A	1	teaches toward DMP student objectives
	2	provides printed and manipulative materials
	16	demonstrates mastery of DMP student objectives
B	3	focuses on the problem or objective of the activity
	9	asks for validation of statements
	10	questions rather than lectures
	11	uses small groups, pairs, etc., as recommended
	17	describes mathematical processes
	20	groups students according to assessment information

TABLE 4

PERFORMANCE CRITERIA FOR JUDGING THE INSERVICE PROGRAM

Objectives for DMP teachers	Criterion level
Objectives 1, 2, and 16 (Category A)	90%
Objectives not in Category A	80%

Category B (Table 3); that is, the teacher should focus on the problem or objective of the activity (Objective 3), ask for validation (Objective 9), question rather than lecture (Objective 10), use small groups or pairs as recommended (Objective 11), describe the mathematical processes emphasized by DMP (Objective 17), and group students according to the assessment information (Objective 20). However, on the basis of data from the pilot studies and judgments by the developers of DMP, it seemed that teachers could do an adequate job of implementing an activity approach to learning mathematics by achieving only five out of the six objectives in Category B. Therefore, achieving mastery of all Category A objectives and all but one of the Category B objectives was considered satisfactory performance by DMP teachers.

One variation in this set of criteria was made for teachers who were not in multiunit schools. Objective 20 is much easier to achieve in multiunit schools where the organizational arrangements provide the flexibility needed for grouping students on the basis of achievement. Therefore, Objective 20 was not considered when judging a teacher from a non-multiunit school on objectives in Category B. Table 5 presents a summary of the performance criteria used in deciding whether a teacher's implementation of DMP's activity approach was adequate. Of course, objectives that were not included in Categories A and B were still desired outcomes of the inservice program, even though they were not part of the criteria used in answering Question 2.

TABLE 5

PERFORMANCE CRITERIA FOR IMPLEMENTING AN ACTIVITY APPROACH TO LEARNING MATHEMATICS

Teachers	Performance criteria
Multiunit	All objectives in Category A* Five out of six objectives in Category B*
Non-multiunit	All objectives in Category A Four out of five objectives in Category B, not including Objective 20

* Categories A and B are defined in Table 3.

The performance criteria discussed in this section were used in making judgments about the effectiveness of the inservice program, and are referred to again in Chapter 6 along with the data from the main study. Before presenting that data, however, the next chapter will discuss the conduct of the study.

Chapter 5

THE CONDUCT OF THE STUDY

The pilot studies reported in the previous chapter provided some evidence of the appropriateness of the inservice program and the evaluation procedures, the two main elements of the design of the study. Therefore, the study was conducted according to the original plans as discussed in the design reported in Chapter 3. However, because of the needs of the particular schools and teachers that participated in the study, there were some variations in the inservice program. These variations will be reported in this chapter, along with a description of the participants in the study and the details of the application of the evaluation procedures.

Participating Schools and Teachers

As indicated in Chapter 3, the study was conducted in conjunction with the field test of the kindergarten and first-grade levels of DMP. Eight schools were chosen to participate in the field test--four multiunit schools from rural and suburban areas of Wisconsin and four inner-city schools from Milwaukee and Chicago. Schools with widely varying characteristics were chosen so that the DMP field test would include students with markedly different backgrounds.

The multiunit schools. These schools all followed a multiunit organizational pattern similar to that in Figure 1; students in the school were divided up into units of 50 to 150 children, and each unit was taught by a team of two to six teachers. Two of the schools had kindergarten units that were separate from the first-grade students, and in the other two schools kindergartens appeared to operate fairly autonomously within the unit; this seems to be a natural situation caused primarily by the fact that kindergartners attend school only half-days. Except for this special independence of the kindergarten teachers, the teams tended to operate according to the recommended practices for the multiunit school. (See Klausmeier, Quilling, Sorenson, Way, & Glasrud, 1971, for a complete description of the operation of multiunit schools.)

All of the multiunit schools had had previous contact with the Wisconsin Research and Development Center, but none of them had been involved with DMP. Three of the four had been in operation as multiunit schools for one year or more before the start of the field test; the fourth was new to the multiunit organization. All of these schools had had special training programs in multiunit operations, including particularly the use of behavioral objectives and assessment procedures for grouping students on the basis of achievement. In these schools teachers did not always work with the same group of students, nor were they always in the same classroom.

The students in the multiunit schools came mostly from white middle-class homes in small towns or suburban-like areas of larger cities.

The inner-city schools. In contrast to the multiunit schools, all of the inner-city schools were organized into self-contained classrooms, where teachers worked with the same students throughout the year rather than sharing the teaching responsibilities as members of a team. None of these schools had had any previous contact with the Center.

In three of the schools, almost all of the students were black, while the fourth had a substantial number of Spanish-speaking students along with members of several other ethnic groups. Each school had an integrated faculty. The neighborhoods served by the schools were generally of low socioeconomic status.

Teachers. At the beginning of the school year there were 40 women in the eight schools who were teaching at the level of kindergarten or first grade; all of these teachers agreed to participate in the field test. Of these teachers, 21 taught in multiunit schools, and 19 in inner-city schools. During the study, two first-grade teachers left their positions, one from each type of school; this left 38 teachers as participants in the study (see Table 6), a mortality rate for the experiment of only 5%.

All of the teachers in the study had at least a Bachelor's degree, and three of them had completed their Master's. Some received their degrees as early as the 1930's, while others were 1971 graduates.

TABLE 6

PARTICIPATING TEACHERS

Description	Multiunit School	Inner-city School	Total
All K-1 teachers	21	19	40
Teachers who changed employment during study	1	1	2
Teachers included in the study	20	18	38

The teachers varied widely in age and in years of teaching experience. Ages ranged from the early 20's to over 60, with a mean of about 40; some teachers had over 30 years of experience, while for others, this was the first year of teaching. The mean number of years of experience, counting the year of the study, was 14, and for the teachers with experience, most of them had taught at their current grade level for the major part of the past five years.

From this description of the teachers, it appears that they are not unusual in their educational background, age, or years of experience. In fact, they seem to be quite similar on these characteristics to the teachers studied by Goodlad, Klein, and Associates (1970) in their investigation of teacher practices. Relationships between teacher performance and these (and other) teacher characteristics will be reported in Chapter 6.

The Conduct of the Inservice Program

The inservice program was generally carried out according to the specifications of the design, but there were some variations. In five of the eight schools, the variations were minor, consisting only of slight changes due to scheduling problems; for example, in some of these schools the two-day workshop could not be held on successive days. In the other three schools, however, all located in the inner city, only a one-day workshop was possible. The one-day workshop included a condensed version of all the agenda items, except for the film, which was omitted.

The brevity of the one-day workshop was compensated for in two ways. First, a staff member was assigned to give individual help to teachers in the three inner-city schools that received only a one-day workshop. The staff member spent from two to four hours consulting with each teacher during the first half of the semester. Second, the schedule of inservice meetings in these schools was extended to include two extra meetings. One of these meetings presented a videotape of an experienced DMP teacher conducting an activity; the videotape and the discussion of it covered the same topics as the film shown at the other workshops. In the other inservice meeting, the mathematical content of DMP, particularly the geometry, was discussed in an attempt to compensate for the brief treatment the subject received in the one-day meeting.

Just as individual help was given to teachers who attended the workshop that lasted only one day, teachers who did not attend a workshop at all were provided with extra consulation time by a staff member. Of the seven teachers who were absent from their workshop, all but one taught in the same three inner-city schools that had had the one-day workshop (Table 7), so these teachers were already receiving compensatory training. Teachers who missed an inservice meeting were also given extra help. This was not a major part of anyone's training, however, since no teacher missed more than one of the four main inservice meetings.

TABLE 7

ATTENDANCE AT THE SUMMER WORKSHOP

Teachers	Number Absent	Number Present	Total
Multiunit	1	19	20
Inner-city	6	12	18
Total	7	31	38

Most of the teachers participated in the field test quite willingly, but some teachers indicated during the inservice meetings that they had not wished to become involved. There were two groups of teachers who expressed these reservations. One group included eight of the thirteen kindergarten teachers; these eight teachers had become accustomed to teaching "their own" mathematics programs--programs which they had designed to teach their children the mathematics that they believed to be important, usually counting and writing numerals. These kindergarten teachers were naturally a bit reluctant at first to give up programs of their own design in order to implement DMP, particularly since DMP begins by studying processes that are important in solving mathematical problems, rather than with counting and writing numerals. However, all of these teachers participated actively in the inservice program, and even though they were somewhat skeptical initially, they were willing to give DMP materials a fair try in the classroom.

The other group who expressed some reservations about participating in the field test included all six teachers from one of the inner-city schools. These teachers indicated that the school administration had given them little choice in the decision to participate in the field test, and some of them were reluctant to use DMP and its activity approach to learning mathematics. One teacher expressed a fear of being sued if she let children use manipulative materials and they hurt themselves. And in her view, reading was more important than mathematics, so she preferred to spend her time on language development. However, most of the teachers in this inner-city school, in spite of their reservations, participated willingly in the inservice meetings, and by the end of the inservice training period, all but two of them were using DMP materials regularly in their classrooms. The change in the views of these six teachers was reflected in their attendance at inservice meetings; while four of them did not attend the inital inservice workshop, all of them were present for the mid-year workshop in January.

Both of the groups of teachers who had reservations about implementing DMP and its activity approach to learning mathematics became much more positive in their outlook by the end of the inservice program. One of the main factors in this change of outlook, in addition to the inservice program itself, appeared to be the favorable reaction of students to the program. During the inservice meetings teachers reported that the children did not want to stop "math class" and that they would "usually pick math" if they were given an opportunity to choose something to work on during free time. These favorable reports appeared to encourage the teachers who had initially been somewhat reluctant to implement DMP.

In summary, the conduct of the inservice program generally followed the design presented in Chapter 3; the differences between the design and the conduct of the inservice program resulted mostly from the problem of scheduling the inservice workshop in three inner-city schools. The teachers generally reacted favorably to both the workshop and the inservice meetings. Eighty-three percent of the teachers who responded on Questionnaire C indicated that they had found the workshop to be a useful experience, and 85% of the teachers gave the inservice meetings a positive evaluation. It was also the opinion of the observers that the inservice meetings were successful in providing encouragement and support for the teachers as well as information that would help them implement DMP and its activity approach to learning mathematics.

As the inservice program ended, the evaluation procedures were begun. The next section of the report describes the application of the procedures designed to evaluate the effectiveness of the inservice program.

The Application of the Evaluation Procedures

The evaluation procedures were carried out according to the specifications of the design. Data were gathered by observation and questionnaire on all 38 teachers, and interviews were conducted with 21 teachers who were randomly sampled from each grade level.

The observations were carried out by the same two observers who participated in the pilot study of the evaluation procedures. Both of the observers were experienced teachers of secondary school mathematics, both had Master's degrees, and both were graduate students at the time of the study. The observers conducted the inservice meetings, and also assisted in the workshops. They were very familiar with the materials that the teachers were using in the field test. For a record of the observers' activities, see Appendix E.

The observers saw 27 of the 38 teachers on all four observation days, and nine more of the teachers were observed on three days. The other two teachers were observed on fewer than three days, so they could receive only non-mastery or inconclusive ratings on the objectives that were assessed by observation. The mean number of observations per teacher was 5.0, with a range from one to eight observations per teacher. Two teachers were observed fewer than three times, two others were observed exactly three times, and the remaining 34 teachers were observed on four or more occasions. No teacher was observed more than three times on a single day.

The inservice and evaluation work was shared about equally between the two observers (X and Y), although one observer (Y) did have to leave the study halfway through the fourth and final round of observations. Of the 38 teachers in the study, all but two were seen by both observers. These two teachers were absent or unavailable on the occasions when Observer Y was in their schools. Summary data on the activities of the observers are found in Table 8.

In addition to the pretest and posttest of inter-observer agree-

TABLE 8

SUMMARY OF OBSERVERS' ACTIVITIES

Observer	Number of Observations	Mean Number of Observations per Teacher
X	101	2.66
Y	89	2.34
Total	190	5.00

ment reported in Chapter 4, further analyses of the observational data were undertaken in order to gain more information on the reliability of the observations. Some differences were found between the observers in the number of times during an observation that they judged the teacher's performance to be unsatisfactory (Table 9). While it was usually the case that not every behavior could be judged in a single five-minute observation, the observer generally made 15 to 20 judgments per observation as he determined whether teacher performance was satisfactory or unsatisfactory on the objectives that were appropriate at that time. Of these 15 to 20 judgments per observation, Observer X averaged 1.1 judgments of unsatisfactory performance, compared to 0.6 for Observer Y. These differences could have resulted from a number of factors. For example, the activities vary considerably in how difficult they are to teach, and the observers did not always see the same activities. Also, the two teachers whose frequent absences prevented Observer Y from seeing them were a rich source of unsatisfactory performance for Observer X. Eliminating these two teachers would reduce the ratio for Observer X to 1.0 while leaving Observer Y's ratio unchanged. These types of variations in what was observed may account for the differences between observers, or these differences could have resulted from a lack of agreement between judges on what constituted unsatisfactory performance.

TABLE 9

DIFFERENCES BETWEEN OBSERVERS IN JUDGMENTS OF UNSATISFACTORY PERFORMANCE

Observer	Number of observations	Number of judgments of unsatisfactory performance	Ratio of judgments of unsatisfactory performance to observations
X	101	110	1.1
Y	89	49	0.6

A re-analysis of the data from the pretest and posttest of inter-observer agreement indicated that no differences in the number of judgments of inadequacy existed on either test. However, in view of the possibility that differences developed between the observers during the study on what constitutes unsatisfactory performance, it would be important for the observers to have seen each teacher about the same number of times. Data indicating the distribution of the differences between the observers on the number of times that they saw each teacher is presented in Table 10. For 34 out of the 38 teachers, the difference between the number of times that the teacher was observed by X and the number of times she was observed by Y was no more than two. Therefore, even if there were slight differences between the observers on judging unsatisfactory performance, and the tests of inter-observer agreement indicate that there were not, these differences would have been distributed fairly evenly over the teachers in the study. Thus any differences that might have existed between observers should have

TABLE 10

DIFFERENCES BETWEEN OBSERVERS IN NUMBER OF OBSERVATIONS OF A TEACHER

The number of teachers who were observed:	
The same number of times by each observer	9
Once more by one observer than the other	13
Twice more by one observer than the other	12
Three times more by one observer than the other	3
Four times more by one observer than the other	1
Total Number of Teachers	38

had no important effect on the results of the study since these results are based on pooled data from the two observers.

In addition to the observations, data were also gathered by questionnaire and by interview. The questionnaires were administered during a half-day workshop; these workshops were held during January and February after all the observations had been completed. The main purposes of the mid-year workshop were to gather data from the teachers, to discuss with the teachers the results of the field test up to that point, and to continue the inservice training in areas where the teachers need more help. All the teachers in the study attended the mid-year workshop; no one was absent, even though a snowstorm cut short one workshop and a flu epidemic in one school caused another workshop to be postponed.

The teachers completed Questionnaire A during the workshop. Since Questionnaire A included some items that assessed the teachers' knowledge of the materials, it was emphasized that the teachers should respond independently; they generally did, although testing conditions were often less than ideal. Questionnaires B and C, which gathered information on the teachers' background and opinions, were given to the teachers during the mid-year workshop. In order to keep the workshop from becoming too long, the teachers were given postage-paid envelopes and told that they could send in Questionnaires B and C by mail. All but two teachers returned the questionnaire as requested.

In addition to gathering data by observation and by questionnaire, the field test staff interviewed 21 teachers about their records of student achievement. These 21 teachers were selected randomly from within each grade level, and the interviews were conducted according to the procedures outlined in Chapter 3.

In summary, the application of the evaluation procedures--observations, questionnaires, and interviews--followed the specifications of the design of the study. The results of the evaluation of the effectiveness of the inservice program are reported in the next chapter.

Chapter 6

RESULTS

In order to evaluate the effectiveness of the inservice program, data were gathered on the performance of all 38 teachers in the study. Following the procedures described in Chapter 3, each teacher was given a mastery, non-mastery, or inconclusive rating on each of the 24 objectives listed in Appendix A. This chapter reports first the ratings on each objective for both the 20 multiunit teachers and for the 18 inner-city teachers by grade level; thus the first section of this chapter presents a summary of the data on teacher performance for these four groups of teachers. Since there are only six kindergarten teachers in multiunit schools and only seven in inner-city schools, the cell sizes are too small to provide meaningful answers to the three main questions of this study, as stated in Chapter 1. Therefore, the da a are further analyzed and presented again in the later sections of this chapter in order to answer the three questions of the study.

Summary of Teacher Performance Data

As indicated in Table 11, almost all of the teachers in the study chose to do activities that would help students achieve the objectives of the program (Objective 1) and to provide the materials needed for the activities (Objective 2). Only three of the first-

TABLE 11

RATINGS OF MULTIUNIT AND INNER-CITY TEACHERS BY GRADE LEVEL ON OBJECTIVES 1-2

Grade	Multiunit Teachers			Inner-city Teachers		
	Mastery	Non-mastery	Incon-clusive	Mastery	Non-mastery	Incon-clusive
			Objective 1			
K	6	0	0	7	0	0
1	14	0	0	8	2	1
			Objective 2			
K	6	0	0	7	0	0
1	14	0	0	9	1	1

grade, inner-city teachers did not receive mastery ratings on both of these objectives; two of these three teachers were observed on fewer than three days, and according to the procedures established for the study, were assigned only non-mastery or inconclusive ratings. Therefore, these two first-grade, inner-city teachers will always be included in the non-mastery or inconclusive categories for objectives assessed primarily by observation (Objectives 1-16 and 22).

Table 12 presents the data on the objectives related to the teachers' structuring comments. Most teachers did focus the activity on a problem or an objective (Objective 3) and explained the activity clearly (Objective 5). However, the teachers did not do as well on relating the activity to earlier work (Objective 4) or on closing the activity with a discussion of what the children had learned (Objective 6). While kindergarten teachers received fewer inconclusive ratings on Objective 6, this appeared to be due in part to the fact that they had been observed an average of six times each while the mean number of observations of first grade teachers was less than five.

The data on objectives related to teacher-student interaction are presented in Table 13. Multiunit teachers did a better job of using student ideas (Objective 7) and they criticized student contributions less frequently (Objective [illegible]) than did inner-city teachers.

TABLE 12

RATINGS OF MULTIUNIT AND INNER-CITY TEACHERS BY GRADE LEVEL ON OBJECTIVES 3-6

Grade	Multiunit Teachers			Inner-city Teachers		
	Mastery	Non-mastery	Inconclusive	Mastery	Non-mastery	Inconclusive
Objective 3						
K	6	0	0	7	0	0
1	14	0	0	9	0	2
Objective 4						
K	2	4	0	3	1	3
1	8	0	6	5	3	3
Objective 5						
K	6	0	0	7	0	0
1	13	1	0	8	1	2
Objective 6						
K	5	0	1	5	0	2
1	5	0	9	4	0	7

TABLE 13

RATINGS OF MULTIUNIT AND INNER-CITY
TEACHERS BY GRADE LEVEL ON OBJECTIVES 7-10

Grade	Multiunit Teachers			Inner-city Teachers		
	Mastery	Non-mastery	Incon-clusive	Mastery	Non-mastery	Incon-clusive
			Objective 7			
K	6	0	0	5	2	0
1	13	1	0	7	3	1
			Objective 8			
K	6	0	0	6	1	0
1	14	0	0	7	3	1
			Objective 9			
K	5	1	0	4	3	0
1	9	5	0	6	5	0
			Objective 10			
K	6	0	0	7	0	0
1	13	1	0	9	0	2

While these differences do not involve a large number of teachers, the ratings indicate some ways in which the two types of schools differ. Many teachers in both kinds of schools did not use probing questions (Objective 9); only kindergarten teachers in multiunit schools achieved this objective fairly consistently. However, almost all teachers chose to use questioning and discussion techniques, as opposed to lecturing (Objective 10).

Most teachers organized their classrooms appropriately for an activity approach. They had children work in small groups when appropriate (Objective 11), and they moved from group to group, acting as a resource person (Objective 12). The data for these two objectives are summarized in Table 14. In addition the teachers usually allowed children to move purposefully about the room (Objective 13) and to interact with other children while working on activities (Objective 14). Teachers also arranged their rooms appropriately for an activity approach (Objective 15). Table 15 includes the data on Objectives 13-15.

As Table 16 indicates, the teachers had no difficulty in mastering the mathematical objectives of their students (Objective 16). However, teachers did have some difficulty in describing the mathematical processes emphasized by the materials they were using (Objective 17). Again, kindergarten teachers in multiunit schools did somewhat better than the other teachers (Table 16).

TABLE 14

RATINGS OF MULTIUNIT AND INNER-CITY TEACHERS BY GRADE LEVEL ON OBJECTIVES 11-12

Grade	Multiunit Teachers Mastery	Non-mastery	Incon-clusive	Inner-city Teachers Mastery	Non-mastery	Incon-clusive
			Objective 11			
K	6	0	0	7	0	0
1	14	0	0	9	1	1
			Objective 12			
K	6	0	0	7	0	0
1	14	0	0	9	0	2

TABLE 15

RATINGS OF MULTIUNIT AND INNER-CITY TEACHERS BY GRADE LEVEL ON OBJECTIVES 13-15

Grade	Multiunit Teachers Mastery	 Non-mastery	 Incon-clusive	Inner-city Teachers Mastery	 Non-mastery	 Incon-clusive
			Objective 13			
K	6	0	0	7	0	0
1	14	0	0	9	0	2
			Objective 14			
K	6	0	0	7	0	0
1	14	0	0	9	1	1
			Objective 15			
K	6	0	0	7	0	0
1	14	0	0	9	1	1

TABLE 16

RATINGS OF MULTIUNIT AND INNER-CITY
TEACHERS BY GRADE LEVEL ON OBJECTIVES 16-17

Grade	Multiunit Teachers			Inner-city Teachers		
	Mastery	Non-mastery	Incon-clusive	Mastery	Non-mastery	Incon-clusive
			Objective 16			
K	6	0	0	7	0	0
1	14	0	0	8	0	3
			Objective 17			
K	5	1	0	3	4	0
1	7	7	0	7	3	1

The remaining objectives deal with managing instruction in order to provide for individual differences. Since teachers in multiunit schools have extra background and experience in this area, it is not surprising that they usually did somewhat better than inner-city teachers on Objectives 18-24. As Table 17 indicates, first-grade teachers in inner-city schools often did not assess students and keep records of student achievement (Objective 18), and most inner-city teachers could not adequately describe the purposes of the various assessment instruments (Objective 19). First-grade teachers in multiunit schools generally grouped students according to achievement (Objective 20), and only kindergarten teachers in multiunit schools appeared to be aware of the relationship between activities and objectives in the materials for teachers (Objective 21).

Data on the remaining three objectives related to managing instruction are included in Table 18. Only a few teachers were observed when demonstrating mastery of Objective 22, which dealt with re-directing students when they finished an activity. While no group of teachers did particularly well on classifying a hypothetical set of students into those who had achieved the prerequisite behaviors for a topic and those who had not (Objective 23), first-grade teachers did slightly better on this objective than kindergarten teachers. On Objective 24 multiunit teachers tended to do better than inner-city teachers on identifying the various options dealing with choosing and

TABLE 17

RATINGS OF MULTIUNIT AND INNER-CITY TEACHERS BY GRADE LEVEL ON OBJECTIVES 18-21

Grade	Multiunit Teachers			Inner-city Teachers		
	Mastery	Non-mastery	Incon-clusive	Mastery	Non-mastery	Incon-clusive
Objective 18						
K	4	2	0	6	0	1
1	12	0	2	5	5	1
Objective 19						
K	4	2	0	3	4	0
1	13	1	0	5	5	1
Objective 20						
K	2	4	0	4	3	0
1	12	2	0	4	7	0
Objective 21						
K	4	2	0	1	5	1
1	6	8	0	4	6	1

TABLE 18

RATINGS OF MULTIUNIT AND INNER-CITY TEACHERS BY GRADE LEVEL ON OBJECTIVES 22-24

Grade	Multiunit Teachers Mastery	Multiunit Teachers Non-mastery	Multiunit Teachers Incon-clusive	Inner-city Teachers Mastery	Inner-city Teachers Non-mastery	Inner-city Teachers Incon-clusive
Objective 22						
K	2	1	3	1	1	5
1	3	1	10	1	1	9
Objective 23						
K	3	3	0	3	4	0
1	9	5	0	6	5	0
Objective 24						
K	5	1	0	3	3	1
1	11	2	1	3	6	2

sequencing the activities that were included in the teachers' materials.

This section of the chapter has presented a summary of the data on teacher performance for four groups of teachers--kindergarten and first grade teachers in multiunit and inner-city schools. In the next section the data will be characterized in terms of the three main questions of the study. These questions were originally stated in Chapter 1; they are repeated below for the convenience of the reader.

Question 1: What proportion of the teachers achieve each objective of the inservice program?

Question 2: What proportion of the teachers in the study implement an activity approach to learning mathematics?

Question 3: What are the characteristics of the teachers who fail to implement an activity approach in their classroom, and are these characteristics similar to or different from the identifying features of non-adopters of other innovations?

Data on Question 1

The effectiveness of the inservice program was measured by determining how many of the teachers achieved the objectives related to implementing an activity approach to learning mathematics (Appendix A). This section of the paper answers Question 1 by reporting whether the criterion levels set for the inservice program were reached. These criterion levels were as follows: 90% of the teachers should master Objectives 1, 2, and 16, and 80% should master all other objectives.

The results of the study are reported in terms of the number of teachers who received a mastery rating on each objective. Important differences between subgroups of the teachers will be noted when they occur.

Use of DMP materials: Objectives 1 and 2. Almost all of the teachers chose to do activities that taught toward DMP student objectives (Objective 1) and provided the printed and manipulative materials that were needed for the activities (Objective 2). Thus the teachers reached the criterion level of 90% on each of these objectives (Table 19). Both objectives were assessed by observation.

One teacher received a non-mastery rating on each of these objectives; she indicated that after more than 30 years of teaching and with retirement near, she had no desire to become "active" in any "activity approach." She was observed teaching mathematics only once; on the other occasions when an observer was present, she did not teach any mathematics at all. Another teacher received an "in-

TABLE 19

TEACHER ACHIEVEMENT OF OBJECTIVES 1 AND 2

Rating	Objective 1		Objective 2	
	Number	Percent	Number	Percent
Mastery	35	92.1	36	94.7
Non-mastery	2	5.3	1	2.6
Inconclusive	1	2.6	1	2.6

conclusive" rating on both objectives because she was observed only twice due to absences because of illness, and the procedures of the study required at least three observations before a mastery rating could be assigned. These two teachers will always be included in the non-mastery or inconclusive categories for objectives assessed by observation.

Structuring comments: Objectives 3-6. The four objectives that involved the teachers' structuring comments were all assessed by observation. The results of the observations indicated that the inservice program was successful in helping teachers achieve two of these objectives. The teachers were generally able to provide a focus for the activity by identifying a problem for the children to solve or an objective for them to achieve (Objective 3); also, teachers had usually prepared well enough so that they could explain the activity in a clear and well-organized manner (Objective 5). The criterion level of 80% for these two objectives was surpassed in each case (Table 20).

However, the 80% criterion level was not reached on two other objectives that deal with the teachers' structuring comments (Table 21). Only 47% of the teachers related the activity that children were working on to what had been done earlier (Objective 4). Some teachers tended to present activities in isolation as though today's problem about how to identify pictures with line symmetry, for example, was not related to yesterday's work on paper folding.

TABLE 20

TEACHER ACHIEVEMENT OF OBJECTIVES 3 AND 5

Rating	Objective 3		Objective 5	
	Number	Percent	Number	Percent
Mastery	36	94.7	34	89.5
Non-mastery	0	0.0	2	5.3
Inconclusive	2	5.3	2	5.3

Also, half of the teachers were never observed bringing the children together at the end of an activity to discuss what they had

TABLE 13

TEACHER ACHIEVEMENT OF OBJECTIVES 4 AND 6

Rating	Objective 4		Objective 6	
	Number	Percent	Number	Percent
Mastery	18	47.4	19	50.0
Non-mastery	8	21.1	0	0.0
Inconclusive	12	31.6	19	50.0

accomplished, what problems they had solved (Objective 6). One of the reasons that this objective was not achieved more often is that mathematics class periods tend to be short. By the time a teacher introduces an activity, breaks the class into small groups to work on the activity, and moves from group to group asking and answering questions, the class period is over and there is no time left to discuss with the children what they learned. Short class periods may be appropriate for drilling children in arithmetic, but in an activity approach, longer class periods appear to be more desirable, since they would provide additional opportunities for extended discussions of mathematical topics by children and teachers.

Many of the ratings on Objectives 4 and 6 were inconclusive, as was predicted on the basis of the pilot study. If more observations had been possible, a substantially higher percentage of teachers might have received mastery ratings on Objective 6.

Teacher-student interaction: Objectives 7-10. The four objectives dealing with teacher-student interaction were related to the teachers' use of student ideas, their tendency to criticize, and their questioning techniques. All four of these objectives were assessed by observation.

The research on classroom interaction, summarized by Flanders (1969), indicates that one characteristic of effective teachers is their use of student ideas (Objective 7)--that is, teachers who repeat, modify, or summarize student contributions seem to have classes that achieve more. Teachers in this study met the criterion level of 80% for Objective 7, although multiunit school teachers tended to receive more mastery ratings than inner-city teachers (Table 22).

Objective 8, which deals with teacher criticism, is another behavior that tends to be related to student achievement. Over 80% of the teachers achieved this objective, but again there were differences between multiunit and inner-city schools, where a few teachers tended to be overly critical of student performance. One teacher, for example, was heard berating a student during mathematics class, telling him that what he had done was stupid. The differences in teacher criticism found in this study (Table 22) are consistent with the results of Goodlad, Klein, and Associates (1970, p. 92), who found less freedom and harsher discipline for children in inner-city class-

TABLE 22

TEACHER ACHIEVEMENT OF OBJECTIVES 7 AND 8

Rating	Multiunit Teachers Number	Multiunit Teachers Percent	Inner-city Teachers Number	Inner-city Teachers Percent	All Teachers Number	All Teachers Percent
Objective 7						
Mastery	19	95.0	12	66.7	31	81.6
Non-mastery	1	5.0	5	27.8	6	15.8
Inconclusive	0	0.0	1	5.6	1	2.6
Objective 8						
Mastery	20	100.0	13	72.2	33	86.8
Non-mastery	0	0.0	4	22.2	4	10.5
Inconclusive	0	0.0	1	5.6	1	2.6

rooms.

Another aspect of classroom interaction is the teacher's questioning behavior. Objective 10 assessed whether the teacher used questioning and discussion techniques, rather than lecturing; almost all teachers did (Table 23). However, many teachers did not follow their questions by asking students to validate or justify their answer (Objective 9). Instead, the tendency for some teachers

TABLE 23

TEACHER ACHIEVEMENT OF OBJECTIVES 9 AND 10

Rating	Objective 9		Objective 10	
	Number	Percent	Number	Percent
Mastery	24	63.2	35	92.1
Non-mastery	14	36.8	1	2.6
Inconclusive	0	0.0	2	5.3

was to ask a question, declare the answer right or wrong, and ask another (or the same) question of a different student. A number of teachers appeared to be unwilling or unable to give up their role as the authority who tells children what is mathematically correct or incorrect rather than helping children develop their own ability to validate mathematical statements. Data on Objective 9 are included in Table 23; the criterion level of 80% was not reached for this objective. There was little difference between multiunit and inner-city teachers on this objective, nor were there differences between grade levels.

Organization of the classroom: Objectives 11-15. An activity-approach classroom has certain environmental characteristics: the children often work in small groups (Objective 11), the teacher is a resource person who moves from group to group (Objective 12), the children move about the room (Objective 13) and discuss their work with other students (Objective 14), and the classroom is arranged so that groups have a place to meet and work (Objective 15). Only two of the teachers failed to achieve all five of these objectives, each of which was assessed by observation.

While some of the teachers expressed doubt that students in the primary grades could work together profitably in small groups, most of them did organize the students into groups according to the recommendations for the activities (Objective 11). Some of the teachers expressed considerable surprise at how well their students could cooperate and learn without the teacher being directly involved. After organizing the children into groups, the teacher was expected to move from one group to another in order to ask and answer questions (Objective 12). The criterion level of 80% was exceeded for both of these objectives (Table 24).

In an activity-approach classroom, children should be allowed to move about the room to get the materials that they need for solving the problems that are being worked on in the activity (Objective 13). Also, teachers were asked to allow children to discuss their work among themselves (Objective 14). Teachers were rated as having achieved these two objectives if their students did in fact move about the room and talk to each other. As indicated in Table 25, almost all teachers achieved Objectives 13 and 14.

TABLE 24

TEACHER ACHIEVEMENT OF OBJECTIVES 11 AND 12

Rating	Objective 11		Objective 12	
	Number	Percent	Number	Percent
Mastery	36	94.7	36	94.7
Non-mastery	1	2.6	0	0.0
Inconclusive	1	2.6	2	5.3

TABLE 25

TEACHER ACHIEVEMENT OF OBJECTIVES 13 AND 14

Rating	Objective 13		Objective 14	
	Number	Percent	Number	Percent
Mastery	36	94.7	36	94.7
Non-mastery	0	0.0	1	2.6
Inconclusive	2	5.3	1	2.6

Objective 15 dealt with another aspect of the classroom environment, the arrangement of the furnishings and materials in the classroom. For example, teachers were expected to provide areas where small groups could work when this was required for the activity. School buildings varied considerably in age and suitability for an activity approach, so the teacher was rated on how well she did with the room she had. Since a few classrooms were very small with desks nailed to the floor, there was little that could be done to make them into classrooms appropriate for an activity approach. But as Table 26 indicates, most teachers achieved Objective 15.

TABLE 26

TEACHER ACHIEVEMENT OF OBJECTIVE 15

Rating	Objective 15	
	Number of Teachers	Percent
Mastery	36	94.7
Non-mastery	1	2.6
Inconclusive	1	2.6

Objectives 11 through 15 were all achieved by over 90% of the teachers, exceeding the criterion level of 80%. However, achievement of these objectives represents only the minimum performance expected of teachers using an activity approach, and does not mean that the classroom environment was similar for all teachers. On the contrary, the "atmosphere" or "climate" differed considerably from one classroom to another. Some teachers, for example, often encouraged students to work together on activities, while others would tolerate very little talk among the students. Assessing the classroom environment in more detail is possible, but it requires different instruments, different procedures, and more resources than were available for this study.

Mathematical content of DMP: Objectives 16 and 17. The teachers in the study were expected as a minimum to be able to master the DMP student objectives (Objective 16) and to describe the mathematical processes emphasized in DMP (Objective 17). Since the study dealt with only kindergarten and first-grade teachers, it is not surprising that all of the teachers who were observed teaching toward DMP objectives received mastery ratings on Objective 16 (see Table 27), exceeding the criterion level of 90%. This objective will become more of a challenge to teachers of the geometry and probability and statistics strands of DMP at the upper elementary levels.

Teachers were less successful at describing mathematical processes (Objective 17). They were asked in Questionnaire A to describe three of the processes emphasized by DMP--ordering, equalizing, and validating. In the process of equalizing, for example, the child considers two objects that differ on some attribute such as length or weight, and determines how to make the two objects equal on that attribute, either by adding on to the smaller object or taking away from the larger object. If the student has two objects of measure a and b, the process of equalizing allows him to solve the sentences a + x = b and a = b - x. To receive a mastery rating on Objective 17, the teacher had to describe all three processes correctly, and as Table 27 indicates, less than 60% of the teachers achieved this objective. Most of the teachers indicated that they had some idea of what each process was, but their responses were often very brief and inadequate. The criterion level of 80% was not reached for this objective.

TABLE 27

TEACHER ACHIEVEMENT OF OBJECTIVES 16 AND 17

	Objective 16		Objective 17	
Rating	Number	Percent	Number	Percent
Mastery	35	92.1	22	57.9
Non-mastery	0	0.0	15	39.5
Inconclusive	3	7.9	1	2.6

Managing instruction: Objectives 18-24. The objectives in this section deal with managing instruction in order to provide for individual differences; except for Objective 22, each of these objectives was measured primarily by questionnaire. Since the teachers in multiunit schools all had special background in the use of assessment materials in managing instruction, it was expected that they would excel on these objectives. Sometimes they did.

In Objective 18, for example, teachers were expected to assess students and to keep records of student achievement. The multiunit teachers reached the criterion level of 80% on this objective, but the inner-city teachers did not (Table 28).

TABLE 28

TEACHER ACHIEVEMENT OF OBJECTIVES 18 AND 19

Rating	Multiunit Teachers Number	Multiunit Teachers Percent	Inner-city Teachers Number	Inner-city Teachers Percent	All Teachers Number	All Teachers Percent
			Objective 18			
Mastery	16	80.0	11	61.1	27	71.1
Non-mastery	2	10.0	5	27.8	7	18.4
Inconclusive	2	10.0	2	11.1	4	10.5
			Objective 19			
Mastery	17	85.0	8	44.4	25	65.8
Non-mastery	3	15.0	9	50.0	12	31.6
Inconclusive	0	0.0	1	5.6	1	2.6

Data on Objective 18 were collected by both questionnaire and interview, with the results of the interviews largely confirming the questionnaire data. Of the 21 teachers interviewed, 16 presented the records of student achievement that they had reported on the questionnaire. The other five teachers indicated changes in record-keeping procedures during the four to eight weeks between the time of the interview and the questionnaire. One of these five teachers presented completed records at the interview, although earlier in the questionnaire she had reported that she did not keep records of student performance. The other four teachers reported on the questionnaire that they kept records, but did not have them available to show the interviewer. Since there was disagreement between the questionnaire and the interviewer data for these five teachers, none of them was given a mastery rating.

A number of different assessment instruments were provided for the teachers, and they were asked to describe the purposes of these instruments (Objective 19). Again, the multiunit teachers reached the criterion level of 80%, but the inner-city teachers did not (Table 28).

Once teachers had assessed students, they were encouraged to use that information to form instructional groups whose members shared common needs (Objective 20). Many teachers did not follow this recommendation, but instead kept their students together in one instructional group. As Table 29 indicates, the criterion level for Objective 20 was not met. However, there was one subgroup of teachers that did tend to group students by achievement; of the 14 first-grade teachers in multiunit schools, 12 of them (85.7%) received mastery ratings on Objective 20. The reason for the higher ratings achieved by the first-grade, multiunit teachers is that multiunit schools provide opportunities for planning time and flexible movement of students from one teacher to another in order to facilitate the formation of instructional groups with similar needs. Teachers in self-contained classrooms generally did not have the same opportunities.

TABLE 29

TEACHER ACHIEVEMENT OF OBJECTIVES 20 AND 21

	Objective 20		Objective 21	
Rating	Number	Percent	Number	Percent
Mastery	22	57.9	15	39.5
Non-mastery	16	42.1	21	55.3
Inconclusive	0	0.0	2	5.3

DMP instructional activities, like the assessment materials, are structured around mathematical objectives for the student. If a student has not mastered an objective, the teacher should be able to choose an activity that is specifically designed to teach that objective (Objective 21). According to data from the questionnaire, most teachers did not appear to use the code that related activities to objectives, and the criterion level of 80% for Objective 21 was not attained (Table 29).

Classroom observers had noted that teachers in two multiunit schools did seem to choose activities on the basis of the objectives, and the questionnaire data confirmed this. In these two schools, teachers assessed first-grade students on all the prerequisite behaviors for first-grade materials, and then carefully chose activities that would help students improve their level of mastery of the objectives which they had not yet achieved. The process of choosing activities was supervised in each of these schools by particularly capable unit leaders, and nine out of the ten teachers in these two schools received a mastery rating on Objective 21. In the other six schools, however, only six out of 28 teachers achieved this objective. While it was expected that non-multiunit school teachers would not do as well on Objective 21, it was surprising to find substantial differences within the set of four multiunit schools. One reason for the difference in performance between the multiunit school teachers appeared to be the competence and conscientiousness of the unit leaders.

In providing for individual differences, a common problem for teachers is what to do with the child who finishes early. DMP materials make several recommendations about how to re-direct these students (Objective 22); sometimes independent work or additional activities were suggested for these students, and on other occasions peer tutoring was recommended as a way for the faster students to help their classmates. However, only seven of the teachers who were observed appeared to follow these recommendations for re-directing students, as Table 30 indicates. Rather, a common response from teachers to students who had finished early was to tell them to sit down and be quiet. The large number of inconclusive ratings for Objective 22 resulted because often no students finished early during the time when the observer was present.

TABLE 30

TEACHER ACHIEVEMENT OF OBJECTIVES 22 AND 23

Rating	Objective 22		Objective 23	
	Number	Percent	Number	Percent
Mastery	7	18.4	21	55.3
Non-mastery	4	10.5	17	44.7
Inconclusive	27	71.1	0	0.0

Another decision that teachers make in managing instruction deals with determining when a student has mastered prerequisite behaviors well enough so that he can go on to a new topic. Teachers were asked on a questionnaire to classify hypothetical students on the basis of assessment information into two groups, those that were ready for a new topic and those that were not (Objective 23). Only 55% of the teachers did this according to the procedures recommended in the assessment materials (Table 30), substantially less than the criterion level of 80%.

One feature of DMP materials is that teachers are encouraged to choose from among a selection of activities in order to provide instruction that meets the particular needs of their students. These choices involve alternate, optional, and review activities, as well as their sequencing. Teachers were assessed by questionnaire on their ability to identify the various options that were available to them (Objective 24). While the criterion level was not reached for all teachers in the study, 80% of the multiunit teachers did achieve this objective (Table 31).

TABLE 31

TEACHER ACHIEVEMENT OF OBJECTIVE 24

Rating	Multiunit Teachers		Inner-city Teachers		All Teachers	
	Number	Percent	Number	Percent	Number	Percent
Mastery	16	80.0	6	33.3	22	57.9
Non-mastery	3	15.0	9	50.0	12	31.6
Inconclusive	1	5.0	3	16.7	4	10.5

Summary of achievement: Objectives 1-24. The first question to be answered by the study dealt with how well the teachers achieved each of the objectives. Did the teachers reach the criterion levels of 90% for Objectives 1, 2, and 16, and 80% for each of the other objectives? The results are summarized in Table 32.

TABLE 32

SUMMARY OF TEACHER PERFORMANCE

Description	Objective	Criterion Level	
		Attained	Not attained
Use of DMP materials	1	X	
	2	X	
Structuring comments	3	X	
	4		X
	5	X	
	6		X
Teacher-student interaction	7	X	
	8	X	
	9		X
	10	X	
Organization of the classroom	11	X	
	12	X	
	13	X	
	14	X	
	15	X	
Mathematical content of DMP	16	X	
	17		X
Managing instruction	18		X
	19		X
	20		X
	21		X
	22		X
	23		X
	24		X

The teachers reached the criterion level on 13 out of 24 objectives. Of the 11 objectives for which the criterion level was not attained, seven dealt with managing instruction. Teachers in multiunit schools, with their extra background in assessment and individualizing instruction, did reach the criterion level on three of the seven objectives related to managing instruction. Inner-city teachers, who had no special background in providing for individual differences, did not reach the criterion level on any of the seven objectives involved in managing instruction. The implications of these results for evaluating the effectiveness of the inservice program are discussed in Chapter 7.

Data on Question 2

The second major question of this study concerned the proportion of teachers that would implement DMP's activity approach in a minimally adequate way, where adequacy was defined for two groups of teachers. For multiunit school teachers, adequate performance meant mastery of Objectives 1, 2, and 16, and mastery of five out of six of Objectives 3, 9-11, 17, and 20. For inner-city teachers, adequacy was defined in the same way, except for Objective 20; they were expected to master Objectives 1, 2, and 16, and four out of five of Objectives 3, 9-11, and 17. A teacher who satisfied the appropriate definition of adequate performance was called an implementing teacher.

Table 33 presents the data on implementing and non-implementing teachers in multiunit schools and in inner-city schools. Of the 38 teachers in the study, 29 (76%) were classified as implementing teachers. There was a slightly higher percentage of implementing teachers in multiunit schools than in inner-city schools (Table 33), and in kindergarten as opposed to first-grade classrooms (Table 34). The differences, however, are not large.

Of the nine non-implementing teachers, two were rather openly antagonistic toward the field test. They were both older, with many years of teaching experience, and both taught first grade in the same inner-city school whose staff had not wanted to be involved in the field test from the very beginning. They often did not use DMP materials, and in fact preferred a more traditional approach. Another first-grade inner-city teacher, who was absent frequently, had been observed only twice and therefore received only non-mastery or inconclusive ratings on most objectives; this teacher did not express

TABLE 33

MULTIUNIT AND INNER-CITY TEACHERS BY RATINGS ON IMPLEMENTING AN ACTIVITY APPROACH

Category	Multiunit Teachers Number	Percent	Inner-city Teachers Number	Percent	Total Number	Percent
Implementing	16	80.0	13	72.2	29	76.3
Non-implementing	4	20.0	5	27.8	9	23.7

TABLE 34

KINDERGARTEN AND FIRST-GRADE TEACHERS BY RATINGS ON IMPLEMENTING AN ACTIVITY APPROACH

Category	Kindergarten Number	Kindergarten Percent	First-grade Number	First-grade Percent	Total Number	Total Percent
Implementing	11	84.6	18	72.0	29	76.3
Non-implementing	2	15.4	7	28.0	9	23.7

any resentment toward the program. As for the remaining six non-implementers, they seemed to have no unifying characteristics except for inadequate performance on two of the important objectives, usually Objective 9 on asking for validation of statements and Objective 17 on describing mathematical processes. These six teachers included one kindergarten teacher from each type of school, three first grade teachers from multiunit schools, and one more first grade teacher from an inner-city school. A more detailed discussion of the characteristics of non-implementing teachers is included in the next section.

Data on Question 3

The third question investigated by this study is the relationship between certain characteristics of teachers (like age, experience, and professional activities) and their ability to change in order to adopt the behaviors that are involved in implementing an activity approach to learning mathematics. This section of the report will describe the important characteristics of the teachers who participated in the study and summarize the results of the search for characteristics that were related to the teachers' ability to change.

Teachers reported that they did have to change their practices in order to implement an activity approach. Of the 32 teachers who responded, 31 said that they had changed their teaching of mathematics since the previous year. When asked to describe the differences between their present and previous teaching practices, 20 mentioned some of the instructional aspects of an activity approach, such as use of manipulative materials and activities for small groups, and 12 referred to managing instruction using the assessment materials. Smaller numbers mentioned other factors, such as the increased time spent on mathematics and the use of objectives. The changes reported by the teachers seem reasonable, since the previous year most of them had been using one of a number of commercially available mathematics programs.

The teachers generally agreed that they had changed their teaching behavior in using DMP. But some of them, referred to earlier as implementing teachers, were more successful than others in adopting the behaviors that make up DMP's activity approach. Various characteristics of the teachers were investigated to determine if there was any relationship between any of the characteristics and the teachers' ability to change and adopt an activity approach.

Teacher attitude. While the teachers' attitude toward mathematics ranged from highly unfavorable to highly favorable, they reported moderately positive attitudes toward the subject on the average. While five teachers indicated that their attitude toward teaching mathematics was more negative after using DMP, mostly because of the additional work and time that an activity approach takes, 21 reported a more positive attitude because they found DMP's activity approach to be more stimulating and enjoyable.

Implementing and non-implementing teachers showed only small differences in terms of attitude toward mathematics and teaching mathematics, with non-implementing teachers reporting slightly more positive attitudes. Teachers who indicated a more negative attitude toward teaching mathematics after using DMP were not more likely to be classified as non-implementers. In general, teacher attitude did not appear to be an important factor in the teacher's ability to change and adopt an activity approach.

Professional activities. One variable that many investigators believe to be related to an individual's capacity for change is professional activity such as belonging to professional organizations, reading professional publications, and attending professional meetings. Most teachers in this study were involved in these kinds of professional activities. While one teacher reported no involvement in professional activities, others belonged to as many as five educational organizations, read as many as seven educational journals regularly, and had attended up to five professional meetings in the past three years. None of these activities, however, was more characteristic of implementing teachers than of non-implementing teachers. Teachers were also classified by their achievement rating on each objective and their involvement in each type of professional activity. Again, no substantial relationships were found. In addition to considering the three kinds of professional activities separately, the frequencies of all three were combined to provide a single, more general index of professional activity for the teachers in the study. The range of this general index went from zero to fifteen, with a mean of approximately six. Again, there were no differences on this index between implementing and non-implementing teachers, nor was there a relationship between teacher performance on individual objectives and teacher involvement in professional activities.

There are several possible explanations for this lack of a relationship between measures of professional activity and teacher performance on the objectives. First, the measures of professional activity were based on data reported by teachers, and it is difficult to determine the reliability of self-report data. Second, the data on professional activity could have been inadequate because they did not measure the depth of the teachers' involvement or the impact upon the teachers of their professional activity. Third, and perhaps most important, the teachers could find out all that they needed to know about an activity approach from the inservice program, and the power of the inservice training could have overwhelmed any effect that professional activities might have had on teacher performance.

Age and experience. The only characteristics on which implementing and non-implementing teachers appeared to differ at all were age and years of teaching experience. The mean age of implementing teachers was approximately 41, while non-implementing teachers' average age was close to 46. In years of experience, implementing teachers average 12 years, compared to 19 for non-implementing teachers. Since the range of ages was more than 40 years and the years of experience ranged from 1 to 34, these differences are not large relatively, but they appeared worthy of further investigation.

In order to determine whether age and experience were important factors in teacher achievement of specific objectives, teachers were classified by two attributes--age or experience as the first, and rating on an objective as the second attribute. This classification turned up only one objective where differences in achievement appeared to be related to age or experience; the objective dealt with teachers' competence in describing the mathematical processes emphasized by DMP (Objective 17). The results of this objective, classified by age, are presented in Table 35; replacing age by experience yields very similar results, as one would expect.

TABLE 35

TEACHERS CLASSIFIED BY AGE AND ACHIEVEMENT OF OBJECTIVE 17

Age	Rating			Total
	Mastery	Non-mastery	Inconclusive	
20-29	5	2	0	7
30-39	7	4	0	11
40-49	6	1	0	7
50 and over	3	7	1	11
No response	1	1	0	2
Total	22	15	1	38

While the data summarized in Table 35 indicate that older, more experienced teachers did not perform as well as younger teachers on Objective 17, this difference did not carry over to other objectives. Therefore, it appears that the relatively small differences in age and experience that existed between implementing and non-implementing teachers were not indicative of a more general relationship, and that the age-experience factor was not an important influence on the ability of teachers in this study to change and adopt an activity approach.

School characteristics. The differences between teachers in multiunit and inner-city schools were discussed earlier in this chapter, and that discussion will not be repeated here. However, there are two other characteristics of schools that have been suggested as important for changing teacher performance--the teachers' involvement in decision-making procedures and the principal's support for the change.

In this study about half of the teachers reported that they were involved in the decision to participate in the DMP field test. In three schools the teachers played an active role in making the decision to participate; in two schools the teachers were not consulted at all. There was no consistent pattern in the other three schools; apparently some teachers were consulted and others were not. In any case, the differences in decision-making procedures did not appear to be related to differences in teacher achievement of the various objectives. Non-implementing teachers had been involved in the decision to participate in the field test as often as implementing teachers, and in the two multiunit schools where the teachers were not consulted at all, teacher performance was at least as good as in the other schools.

Most of the principals of the schools involved in this study fully supported the school's participation in the field test, according to the teachers. However, in two schools a majority of the teachers reported that their principal's support for DMP was only moderate. The lack of support from these principals, one in a multiunit school and one in an inner-city school, did not seem to affect teacher performance, in contrast to other studies (Chesler, Schmuck, & Lippitt, 1963) where the principal's support was believed to be crucial for implementing change. Not only was teacher performance unaffected, but also the teachers in the multiunit school reported that they were trying to change the principal's opinion of the value of their new approach to mathematics.

The two characteristics of schools that have been discussed in this section--the teachers' involvement in the decision to try a new mathematics program and the principal's support for the change--did not appear to be important factors affecting teacher performance in the present study. This result is contrary to what one would expect after reviewing the literature on educational change (Havelock, 1969). Of course, the data in this study were gathered from only eight schools, too small a sample to provide a definitive result. In addition, the extended period of inservice meetings could have reduced the effect of these school characteristics so much that they would not influence teacher performance.

Summary for Question 3. This study found no characteristics that would differentiate between teachers who are willing to change and adopt new practices and teachers who are not. The search for these characteristics was carried out by classifying the teachers on two variables--the first being performance on one of the 24 objectives, and the other variable being one of the teacher characteristics assessed in the study. The characteristics included highest degree received, year the degree was received, years of teaching experience, age, professional activities, teacher attitude toward mathematics, teacher involvement in decision making, and teacher opinion of the principal's support. An analysis of the classified data indicated that there were no important relationships between teacher performance on any objective and the teacher characteristics; the use of formal correlational statistics was explored but deemed unnecessary due to the small number of teachers in the study.

Characteristics of teachers and schools that other investigators believed to be important did not turn out to be so for the teachers in this study. Of course, the data reported here came from only a small sample of teachers and schools, and no definite conclusions can be drawn.

Now that all of the data on teacher achievement has been presented, the next chapter indicates the conclusions that can be drawn from the data.

Chapter 7

CONCLUSIONS

The data reported in Chapter 6 were organized around the three main questions investigated by the study. This chapter is organized in a similar manner, presenting first the conclusions regarding each of the questions, and then discussing the implications of Question 1 for the revision of the inservice program, the limitations of the study, its implications for mathematics education, and recommendations for future research.

The Effectiveness of the Inservice Program

The first question investigated by the study was the effectiveness of the inservice program in helping teachers achieve each of the objectives related to implementing an activity approach to learning mathematics. The inservice program was successful in helping teachers reach the criterion level for 13 of the 24 objectives (see Table 32 in Chapter 6). These 24 objectives are listed in Appendix A in two main categories--providing instruction (Objectives 1-17) and managing instruction (Objectives 18-24). Objectives in the "providing instruction" category deal with the instructional materials used by the teacher, the teacher's verbal behavior, the classroom organization, and the teacher's knowledge of mathematics. The teachers in the study reached the criterion level on 13 of the 17 objectives related to providing instruction. The other main category of objectives deals primarily with the teacher's use of assessment information in managing instruction so as to provide for individual differences. The proportion of teachers who received mastery ratings on objectives related to managing instruction generally ranged from 40% to 70%, less than the criterion level of 80%; thus the inservice program was not successful in helping teachers reach the criterion level for those objectives. However, it was expected that teachers from inner-city schools would have considerable difficulty mastering objectives related to managing instruction, since the inner-city teachers had no special background in this area. The teachers in multiunit schools, on the other hand, did have special background in managing instruction, and they were expected to have less difficulty achieving objectives related to that area. The data indicated that the expected differences did occur; multiunit teachers reached the criterion level on three of the seven objectives related to managing instruction, while inner-city teachers never attained the criterion level on these seven objectives. In summary, it appears that the inservice program was quite successful in helping teachers achieve the objectives related to providing instruction through an activity approach, but somewhat less successful in helping teachers manage an activity approach so as to provide individually guided instruction in mathematics, particularly in non-multiunit schools. A more detailed discussion of the reasons that were related to the inservice program not reaching the criterion levels for some objectives is included later in this chapter.

The second major question of this study involved the proportion of teachers that achieved a set of objectives that represented minimally adequate implementation of an activity approach to learning mathematics. According to this more global criterion, as described in Chapter 4, 76% of the teachers in the study implemented an activity approach to learning mathematics in at least a minimally adequate way. The inservice program appeared to be about equally effective with all groups of teachers, according to this criterion; for example, there were only small differences between grade levels, with kindergarten teachers doing somewhat better than first grade teachers, and even smaller differences between the two different kinds of schools, with multiunit teachers being rated only slightly higher than inner-city teachers.

The third question investigated by this study was the relationship of teacher characteristics to the teachers' ability to change in order to implement an activity approach to learning mathematics. While the two teachers* who refused to use the materials and disapproved of an activity approach were similar on many characteristics--being older, experienced first-grade teachers from the same inner-city school--there were no teacher characteristics that were consistently related to failure in implementing an activity approach or to unsatisfactory ratings on the individual objectives for teachers. The teacher characteristics that were investigated included attitude toward mathematics and mathematics teaching, involvement in professional activities, age, and years of teaching experience. None of these characteristics appeared to be related to the performance of teachers in this study. In addition,school characteristics, such as teacher involvement in decision-making procedures and the principal's support for implementing a new mathematics program, also appeared to be unrelated to teacher performance. One interpretation of this array of negative findings is that, at least in the present study, the effect of these characteristics of teachers and schools was insignificant compared to the effect of the inservice program. In particular, the series of inservice meetings appeared to be important in providing teachers with the support and encouragement that helped them to change their behavior and implement an activity approach to learning mathematics.

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* More recent reports about these two teachers indicate that their performance changed considerably during the second semester, presumably due to the influence of other teachers in their school.

The answers to the three main questions of the study indicate that the inservice program was effective in most areas. The teachers reached the criterion level for most of the objectives (Question 1), and most teachers were successful in implementing an activity approach to learning mathematics (Question 2). Also, the success of the inservice program was not related to a particular set of teacher characteristics, but rather it seemed to be about equally effective for different kinds of teachers (Question 3). These results give some indication of the adequacy of the design of the inservice program used in the study. The inservice workshop generally presented the teachers with the information that they needed to begin implementing an activity approach, and the continuing series of inservice meetings appeared to be a good means of helping the teachers as they changed their teaching practices.

While the inservice program was successful in most areas, Question 1 of the study identified a number of objectives where the criterion level was not reached. The next section of the paper discusses each of these objectives, suggests reasons why they were not mastered more often, and where appropriate indicates possible revisions in the inservice program.

Implications of Question 1 for the Inservice Program

The data from Question 1 indicate that teachers in the study were not successful in reaching the criterion level of 80% mastery on 11 of the 24 objectives. Four of these objectives were assessed by observation. The most important of these four objectives dealt with asking children to validate or justify their responses rather than to tell students that they were correct or incorrect (Objective 9); this objective was achieved by only 63% of the teachers. Other research has also found that many mathematics teachers seldom use the type of probing questions related to Objective 9 (Fey, 1969; Gall, 1970). Changing teachers' questioning techniques appears to be a difficult task which deserves extra attention during the inservice program.

Three other behaviors that were often not demonstrated by teachers were closing the activity with a discussion (Objective 6), relating the activity to previous work (Objective 4), and re-directing students who finished the activity before others (Objective 22). No teacher received a non-mastery rating on Objective 6; teachers did end the activities with a discussion of what the children had accomplished, whenever possible. One difficulty appeared to be that mathematics classes were often too short for the activities to be brought to a logical conclusion, and therefore many teachers received inconclusive ratings on Objective 6. Appropriate scheduling of school time would help teachers to achieve Objective 6 more regularly. Objectives 4 and 22 also were often not observable, but unlike Objective 6, many teachers received non-mastery ratings on these two objectives.

Some changes in the conduct of the inservice program seem needed to improve teacher performance on the four objectives described above (Objectives 4, 6, 9, and 22). While each of these objectives was discussed and demonstrated during both the inservice workshop and inservice meetings, the teachers did not have an opportunity to practice exhibiting the desired behaviors themselves. Therefore, it is suggested that the inservice program could be strengthened by including an additional two-hour workshop session or two more inservice meetings that would provide teachers with the opportunity to demonstrate each of these behaviors. One procedure for giving teachers a chance to practice these behaviors would be to have each teacher present one activity to a small group of teachers or children; during the presentation, the teacher should relate the activity to earlier lessons that children would have covered (Objective 4), ask probing questions (Objective 9), indicate how students who finished early could be re-directed (Objective 22), and close the activity by discussing what had been accomplished (Objective 6). This type of training would be similar in certain aspects to the microteaching techniques discussed in Chapter 2, and should help teachers improve their performance on these objectives in the classroom.

Objectives 4, 6, 9, and 22 were the only objectives that were assessed by observation where the inservice program did not reach the criterion levels. The other instances when the criterion levels were not attained included all seven objectives that were assessed primarily by questionnaire. One of the main reasons for poor performance on these objectives appeared to be that teachers spent very little time filling out the questionnaires; answers tended to be very brief and consequently were often inadequate. Most teachers showed no concern about the possible evaluation of their responses; of course, the study was designed to promote this kind of non-evaluative atmosphere, which seemed in this case to result in relatively poor performance on the questionnaires. Thus it seems that the evaluator in studies of this type is caught on the horns of a dilemma: if he tells teachers they are being assessed, some of them are likely to report what they should have done, rather than what they did; if he does not tell them that they are being assessed, some teachers may perform lackadaisically on the questionnaire, rather than making a serious attempt to provide complete answers. While an effort was made to avoid either extreme, the results from the present study indicate that the second alternative was probably related to poor performance by teachers on the questionnaire.

Objective 17, which dealt with the teachers' ability to describe the mathematical processes emphasized by DMP, was one of the objectives assessed by questionnaire where the teachers did not do well. Approximately 40% of the teachers received non-mastery ratings on this objective, not because their responses were incorrect, but because their responses were inadequate descriptions of the processes. Since the observers reported that most teachers described the processes adequately to their students, it appears that at least some teachers could have done better if they had been willing to spend more time on the questionnaire. Another factor that is likely to improve teacher performance on Objective 17 is experience in working with DMP materials. The teachers in the pilot study who were experienced in using the materials had no difficulty in describing the processes.

Most teachers in multiunit schools kept records on student achievement (Objective 18) and correctly described the purpose of the various assessment instruments provided to teachers (Objective 19). These assessment materials are a common part of multiunit school procedures. Teachers in non-multiunit schools, however, did not reach the 80% criterion level for these objectives; 61% of the teachers in self-contained, inner-city classrooms received mastery ratings on Objective 18, and 44% mastered Objective 19. Since teachers in non-multiunit schools had had no previous experience in using these kinds of assessment materials, their performance on Objectives 18 and 19 represents considerable improvement on their part, and an extra inservice meeting dealing with these objectives would be likely to improve the teachers' performance even more.

Most teachers did not group students according to achievement (Objective 20). As indicated earlier, this type of grouping is rather difficult to accomplish without the flexibility of the multiunit school organization. In addition, many kindergarten teachers emphasize social development, rather than academic achievement, and have no interest in grouping children on the basis of achievement. Thus the only teachers who consistently received mastery ratings on Objective 20 were first-grade teachers in multiunit schools. Some kindergarten and non-multiunit teachers reported that they had found no need to group students on the basis of achievement; they claimed that they were better able to provide for individual differences in other ways. These teachers may very well be right, at least for kindergarten and first-grade children, and it may be unrealistic to expect them to achieve Objective 20. At higher grade levels, however, where student differences are greater, grouping students by achievement is likely to be seen by more teachers as a useful procedure.

The remaining three objectives on which the teachers' performance was less than satisfactory all dealt with managing instruction--relating objectives to activities (Objective 21), making decisions about prerequisites (Objective 23), and choosing an appropriate sequence of activities (Objective 24). Adequate performance on these three objectives requires only minimal knowledge of how the materials for teachers are organized. The poor performance of all teachers on Objectives 21 and 23 and of inner-city teachers on Objective 24 appeared to result mainly from the fact that these objectives were covered during the workshop, but not emphasized again during the inservice meetings. Periodic reemphasis of these ideas during the inservice meetings should improve teacher performance on these objectives.

In summary, the inservice program was successful in helping teachers achieve most of the objectives. The objectives which were not achieved by a substantial proportion of the teachers dealt with the verbal behavior of the teacher and managing instruction in order to provide for individual differences. To improve teacher performance in these areas it was suggested that two additions be made in the inservice program, including an extra two-hour session on the teachers' verbal behavior and an additional one-hour inservice meeting dealing with managing instruction. These changes in the inservice program should improve the teachers' performance on objectives which were often not achieved without weakening the effectiveness of the inservice program in other areas.

Limitations of the Study

Whenever a study is carried out in a school setting, there are always a large number of extraneous variables that might have had an effect on the results of the study. For example, did an approaching snowstorm cause some teachers to do poor work in filling out their questionnaires because they wanted to leave early and get home before the storm hit? Did a threatened teacher strike have an effect on the way that some teachers and students performed in the classroom? These and other questions could be raised about possible confounding effects in this study. Not all of these effects will be discussed here; for a reasonably complete cataloguing of these kinds of extraneous variables, see Campbell and Stanley (1963). This section of the chapter will discuss only those variables of particular importance in this study.

One of the major limitations of the study is the selection variable--that is, the sample of teachers included in the study may not be representative of any larger population. Rather, schools were selected for the field test in order to try out DMP materials with students from widely differing backgrounds and environments. Therefore, it is not possible to generalize the results of the study to any larger population of teachers.

Another variable that may have been important in the study is the Hawthorne effect caused by the teachers' knowledge of participating in the field test. While the teachers did not appear to be aware of the inservice program reported in this paper, they were aware of the field test procedures for assessing student achievement and made their interest evident. For example, when a random sample of students was selected from a teacher's classroom, it was common for the teacher to tell the field test staff that the students selected included too many "slower" students to be really representative. The teachers apparently were concerned about their students' performance in the field test, and they are no doubt awaiting with interest the published report of the field test which has been promised them. In future studies, teachers who are not involved in a field test may not have this extra motivation to do well in implementing an activity approach to learning mathematics.

Another possible confounder in the study was the effect of the observers on teacher performance. In order to determine if the teachers performed differently in front of the observer than they did normally, follow-up data were gathered from a random sample of 12 teachers on their feelings toward the observations. These teachers were asked if the presence of an observer made teachers in their school uncomfortable or caused them to teach differently. Three teachers thought that the observers made some teachers uncomfortable, and another said that teachers might be more careful about choosing the activity when an observer was present. All but one of the teachers, however, reported that the observers did not cause them any discomfort and that they did not change their teaching when the observer was present. The results of these brief interviews indicate that few, if any, teachers performed differently when the observer was present, corroborating the opinion of the observers. However, it is also possible that the periodic visits by the observers could have had a positive effect on teacher performance without making teachers feel that they were being evaluated. If further research indicates that the teachers' participation in the field test and the presence of observers in the classroom could each have been a factor in improving teacher performance, it may be advisable to include these factors in every inservice program designed to help teachers implement an activity approach. These factors could be included by letting teachers know that the materials being used were being evaluated, and that part of the evaluation included regular observations of student reactions to the materials.

Since it was not possible to pretest teacher performance during the year before the field test, there is no conclusive proof that the teachers' performance changed when they implemented an activity approach to learning mathematics. However, reports from teachers leave little doubt that most of them did change their teaching practices considerably. These behavioral changes were particularly noted by teachers when the change involved DMP materials, such as the assessment or manipulative materials. Changes in the verbal behavior of teachers are, of course, more difficult to determine without pretest data.

While it is clear that the teachers' performance did change, it is not possible to decide on the basis of the present study how much of that change is attributable to the inservice program and how much is due to the materials themselves. Teachers certainly need materials like DMP if they are to implement an activity approach to learning mathematics, and experience in early tryouts of DMP indicates that teachers both want and need inservice training in order to implement an activity approach successfully. The present study has shown that most teachers in the field test were able to perform adequately after they received inservice training, but determining the precise effects of the various parts of the inservice program is a subject for future research.

Recommendations for Future Research

The most direct follow-up to the present study would be to investigate the effectiveness of the various parts of the inservice program. Schools could be randomly assigned to varying treatments, where, for example, Treatment 1 could be the complete inservice program as described in this report, Treatment 2 the inservice workshop only, and Treatment 3 a brief introduction to DMP materials with no real inservice training at all. The same evaluation procedures could be used as in the present study--observations, questionnaires, and interviews. However, it would be very difficult for the observer to avoid holding inservice meetings for teachers in Treatments 2 and 3 if the teachers believed him to have any competence in explaining the materials. Therefore, the observer would have to be clearly identified for the teachers as a person who wanted to see DMP materials in action, but who had no special knowledge of DMP.

Planned comparisons among the three treatments would permit an assessment of the effectiveness of the inservice workshop and the inservice meetings. Careful analysis of the performance of teachers who received no substantial inservice training in Treatment 3 could also provide useful information for school districts which could not afford the inservice program. However, extreme caution would be necessary in dealing with teachers in Treatment 3, for teachers find an activity approach so different from traditional mathematics programs that they feel a definite need for the support and guidance that comes through inservice training. If denying inservice training to these teachers would cause them to become emotionally upset, humanitarian concern may make it necessary to change these teachers to a treatment group receiving some form of inservice training. Due to the possibility that teachers or students could be hurt by being involved in Treatment 3, it would be advisable to try out such a treatment initially in a closely controlled laboratory situation.

In order for an activity approach to learning mathematics to be widely and properly implemented, it appears likely that inservice training will be necessary, and thus a large number of coordinators of inservice programs will need to be trained. The role of the coordinator would be mainly to conduct the inservice program for the teachers, to evaluate the teachers' success in implementing an activity approach to learning mathematics, and to plan further staff development programs on the basis of that evaluation. Therefore, another research study is needed to investigate what kind of training would be appropriate for inservice coordinators. Such a research study is now being carried out by the staff of the mathematics project of the Wisconsin Research and Development Center.

A third type of follow-up to the present study, and perhaps the most important kind of research, is to investigate the effect of teacher performance on student learning. The objectives for teachers in Appendix A are believed by the developers of the materials to be important in helping teachers maximize student learning. The research cited in Appendix A supports this belief. To verify that these teacher behaviors are in fact related to student achievement will no doubt involve a large number of studies over a long period of time. The first such study is now being conducted by a professor at Chicago State University, using data on teachers and students involved in the study reported in this paper. No results are yet available.

Each of the three types of studies just mentioned would be a direct follow-up to the present study. In addition, there are many other areas of research in mathematics education that are related to helping teachers implement an activity approach to learning mathematics. For example, what kinds of preservice training would be most appropriate for elementary school mathematics teachers? Will more of an emphasis on the applications of mathematics, as recommended by the Committee on the Undergraduate Program in Mathematics (1971), help teachers implement an activity approach? Would it be advantageous to integrate the traditional content and methods courses for preservice teachers? These and other questions await the attention of researchers interested in finding ways to help teachers implement an activity approach to learning mathematics.

Implications for Mathematics Education

There is wide support in the mathematics education community for helping teachers implement an activity approach to learning mathematics; also, it is widely acknowledged (Goodlad, Klein, & Associates, 1970) that most teachers are not using an activity approach and that changing the behavior of these teachers is likely to be a very difficult task. The present study provides some indication of procedures that are useful in helping teachers improve their teaching practices.

First, the study demonstrates the utility of specifying teacher behaviors or teacher competencies in order to plan and evaluate inservice programs. The current trend toward stating teacher competencies in terms of behavioral objectives should have a good effect on the quality of the planning and evaluation of inservice training in mathematics. This emphasis on teacher performance in the classroom does not mean that inservice programs should omit discussion of mathematics content, but rather that teachers need help with more than just knowledge of mathematics if they are to change their teaching practices.

One way to provide both training in mathematics and an indication of new teaching methods to elementary school teachers is by having them become "active learners" themselves in a mathematics laboratory. While the value of laboratory work for mathematics teachers is still under investigation, the teachers in the present study did profit from their opportunities to participate in laboratory-type settings. The teachers not only learned some new mathematics, but they also had a chance to make some discoveries on their own and to see how they could provide similar opportunities for their students. Thus it appears that combining training in mathematics content and teaching methods in a laboratory setting should be an effective means of helping both inservice and preservice teachers improve their performance in the mathematics classroom.

Another factor that appeared to be important in helping teachers change their behavior in the present study was the series of regular inservice meetings. In addition to the training that took place during these meetings, the teachers seemed to need the support that came from knowing that others shared their problems and concerns, and that these concerns could be discussed openly without fear of any negative consequences. Such an atmosphere of cooperation and communication is a worthy goal for any group of teachers, and with the appropriate leadership, these kinds of group meetings could have an important effect on teacher performance.

Judging from the response of the participants in this study, teachers are generally interested in and concerned about improving their performance. They want to learn how to use new ideas and new materials for teaching mathematics, particularly when they can see the effect of these changes on their students. But being open to change is not enough; teachers need both instruction and continued support as they change their performance. This portion of the thesis has indicated several important procedures that could be used to improve the teaching of mathematics in the elementary school, and if these procedures are widely implemented and adapted for preservice as well as inservice teacher training programs, improvements in mathematics teaching will result.

Summary

The purpose of this study was to investigate the effectiveness of an inservice training program designed to help teachers implement an activity approach to learning mathematics. The inservice program was successful in helping teachers achieve most of its objectives, and most teachers were able to implement an activity approach in a minimally adequate way. Teacher performance did not appear to be related to teacher characteristics such as age, experience, or professional activities. The study supports the view that a two- or three-day workshop at the beginning of the school year, followed by a series of four to six inservice meetings during the first half of the fall semester, is an effective way to design an inservice program for elementary school mathematics teachers. The evaluation of the inservice program was carried out primarily through classroom observations, but questionnaires and interviews were also used where appropriate. The study was conducted in conjunction with the field test of Developing Mathematical Processes (DMP) materials for kindergarten and first grade, thus following the recommendations of Gallagher, Nuthall, and Rosenshine (1970) that classroom observation of teacher performance should be an integral part of curriculum evaluation.

In contrast to most inservice programs in mathematics, which have normally been remedial courses in mathematics content, the inservice program of this study emphasized the teaching strategies involved in an activity approach to learning mathematics. As Dubisch (1970) points out, the need for remedial inservice training in mathematics is now decreasing, and it is more important to develop procedures designed to maintain teacher competence and to increase professional growth. This study has provided part of the research base needed in the development and evaluation of one such set of procedures--specifically, the procedures involved in an inservice program designed to help teachers implement an activity approach to learning mathematics.

Appendix A

OBJECTIVES FOR DMP TEACHERS

OBJECTIVES FOR DMP TEACHERS

The main purpose of establishing the following objectives for DMP teachers is to provide a basis on which to evaluate the teachers' implementation of the program. Assessing the teachers' achievement of these objectives will provide information on the effectiveness of the DMP inservice program and the usability of other DMP materials. A revised version of these objectives will be developed for future teachers of DMP to guide them as they assess their own effort to implement the program.

The objectives for DMP teachers will be listed here in two main categories--providing instruction and managing instruction. Providing instruction will be subdivided into objectives dealing with the materials used by the teacher, the teacher's structuring comments (such as advanced organizers and post organizers), the interaction between students and the teacher, the organization of the classroom, and the teacher's knowledge of the mathematical content of DMP. Objectives related to managing instruction deal primarily with the decisions that the teacher needs to make in order to provide individually guided education, and how the assessment information is used in making these decisions.

The statement of each objective will be accompanied by whatever extra explanation is required and by one or more ways to measure the achievement of that objective. When classroom observation is used to measure achievement of an objective, the number of each related item of the Observation Schedule will be given. When the assessment is by questionnaire, the number of the item in Questionnaire A will be given. The

Observation Schedule and Questionnaire A are included in Appendix B.

PROVIDING INSTRUCTION

The objectives for DMP teachers specified in this section will deal primarily with the type of instruction provided by the teacher. Sometimes an objective will be subdivided into several parts, and these subcriteria will be used to determine whether a teacher has demonstrated achievement of a particular objective.

Use of DMP Materials

1. The teacher chooses activities (usually but not necessarily from the DMP Teacher's Guide) that help students achieve the objectives of DMP.

Assessment: Observation Schedule - I.2, I.3, and I.4

If the teacher never used any of the activities from the DMP Teacher's Guide, or if the teacher chose to do activities that were in conflict with the objectives of DMP, the teacher's performance on this objective would be considered unsatisfactory.

2. The teacher provides the printed, manipulative, or other materials needed for the activity.

Assessment: Observation Schedule - II.1, II.2, and II.3

The materials needed for each activity are specified in the DMP Teacher's Guide. The printed and manipulative materials that are part of the DMP Curriculum Package should be available for each teacher to use; it is expected that other materials, such as scissors and graph paper, will be available from local sources.

Structuring Comments

3. The teacher identifies the problem or the objective of the ac-

tivity, providing an appropriate focus.

Assessment: Observation Schedule - III.2

4. During the opening or closing of an activity, the teacher states the relationship of the activity to previous work.

Assessment: Observation Schedule - III.1 and III.3

Objectives 3 and 4 are to evaluate the teacher's use of structuring comments that provide an overview of what is to come or a review of what has gone before. Providing this type of cognitive scaffolding seems to be particularly important when beginning or ending an activity (Rosenshine and Furst, 1971, and Romberg and Wilson, 1972).

5. During the opening (or closing) of an activity, the teacher explains (or summarizes) the activity clearly and in a well-organized manner, presenting ideas at a cognitive level appropriate for the students.

Assessment: Observation Schedule - III.4

The clarity of the teacher's presentation is an important variable in teaching, but difficult to measure, involving as it does a high-inference judgement on the part of the observer (Rosenshine and Furst, 1971). To get independent information on this objective, a separate criterion will also be used. This criterion is item III.5 of the Observation Schedule, which asks the observer to state the ratio of the number of students working profitably on the activity to the total number of students involved. Of course, this ratio may also be affected by other factors, such as time of day, that are not related to the clarity of the presentation.

6. During the closing of an activity, the teacher displays and discusses student work, while helping students work for cognitive closure.

Assessment: Observation Schedule - III.6

This objective is very important for some activities, such as when students first begin to construct graphs. For other activities, however, there may be no written work to be discussed and this objective would not apply.

Teacher-Student Interaction

7. The teacher uses student ideas by repeating them, modifying them, applying them, comparing them to other ideas, or by summarizing them.

Assessment: Observation Schedule - V.1

There is considerable research evidence that this type of teacher behavior is related to student achievement and attitude (Flanders, 1969).

8. The teacher does not criticize negatively a student's contributions to a group discussion or to other group work.

Assessment: Observation Schedule - V.3

Negative criticism tends to be correlated with lower student achievement (Rosenshine and Furst, 1971, and Flanders, 1970). The Observation Schedule scores occurrences of negative criticism of student contributions, but not criticism of destructive or dangerous student behavior.

9. The teacher responds to student statements by asking for validation or justification of the mathematical ideas expressed.

Assessment: Observation Schedule - V.2 and V.4
Questionnaire A - Items 8 and 9

Several criteria will be used to assess this objective. First, observers will note occasions when the teacher asks students to validate or justify a mathematical statement (V.2). Second, the observer will make a high-inference judgement as to the teacher's usual behavior--is it that of a mathematical authority figure who normally tells students what is mathematically correct or incorrect (V.4), or is it that of a resource person who encourages students to justify their statements? Third, Items 8 and 9 of Questionnaire A ask the teacher how he would respond to a mathematical statement by a student.

10. The teacher asks questions and leads discussions, rather than lecturing.

Assessment: Observation Schedule - V. 5 and V.6

DMP activities are designed to be used in an inquiry-oriented classroom where the teacher spends very little time lecturing. The two criteria for this objective determine, first, whether the teacher asks questions or not (V.5), and second, whether the teacher relies primarily on questioning methods or lecture methods (V.6).

Organization of the Classroom

11. Given an activity that requires students to work individually, in pairs, in small groups, or in large groups, the teacher organizes the students in the appropriate mode.

Assessment: Observation Schedule - IV.1

The appropriate group size depends on the requirements of the particular activity being used. However, it is expected that the children will spend most of their time in individual and small group activities.

12. The teacher moves from group to group or from individual to individual, acting as a resource person for the students.

Assessment: Observation Schedule - IV.2

This is an important behavior because moving about the room gives the teacher the opportunity to assess the students, to ask probing questions that extend the child's understanding, and to provide extra help when this is needed.

13. The teacher allows students to move purposefully about the room to obtain materials, to consult with others, or for other task-oriented reasons.

Assessment: Observation Schedule - IV.3

14. The teacher allows students to interact verbally while working on the activity.

Assessment: Observation Schedule - IV.4

15. The teacher arranges furnishings and materials in the room in a way that is recommended for the activity by the Teacher's Guide.

Assessment: Observation Schedule - IV.5

In objectives 13, 14, and 15, the teacher is expected to provide a classroom environment that is conducive to an activity approach to learning mathematics. Students, for example, should have access to manipulative materials so that they can validate their assertions empirically, and developmental psychologists such as Lovell (1971) have often noted the desirable effects on learning of student-student interaction. Also, the classroom needs to be arranged so as to provide the facilities needed for the activity, such as areas where small groups can work together solving problems.

Mathematical Content of DMP

16. The teacher demonstrates mastery of the DMP objectives being studied by his students.

Assessment: Classroom Observations

17. The teacher describes the mathematical processes that are being used by his students.

Assessment: Questionnaire A - Item 15

Classroom observations have shown that DMP teachers in kindergarten and first grade do not have any difficulty in mastering the related student objectives. Teachers do have some difficulty, however, in describing the processes that the students use and in seeing where the processes lead. The teachers were asked to describe three of these processes in Questionnaire A.

MANAGING INSTRUCTION

The objectives for DMP teachers specified in this section will deal primarily with the assessment component of DMP, and how the teacher uses assessment information in order to make decisions about managing instruction. Since it is difficult to observe such decisions being made in the classroom, these objectives will usually be tested through questionnaires.

18. Using the appropriate assessment instruments, the teacher assesses students and completes the pupil performance records.

Assessment: Questionnaire A - Items 1 and 5
Observation Schedule - IV.6 and IV.7
Interviews with Teachers

The observer will note when the teacher assesses a student during an activity (IV.6) and when the teacher records that assessment (IV.7). Also, Items 1 and 5 of Questionnaire A ask the teacher for information on the use of the assessment instruments and records. Additional information will be gathered by the staff of the R and D Center as they interview a random sample of teachers on the usability of the assessment materials.

19. The teacher states the roles of the Placement Inventories and Topic Inventories.

Assessment: Questionnaire A - Item 7

20. On the basis of information gathered from Placement Inventories and Topic Inventories, the teacher forms instructional groups based on achievement.

Assessment: Questionnaire A - Items 2 and 6

DMP assessment materials help teachers to place children accurately in the DMP sequence and to determine the children's achievement of each objective. Using this information, the teacher can assign children with similar needs to the same instructional group.

21. When presented with a student who has not mastered an objective, the teacher can choose an activity that will help the student reach that objective.

Assessment: Questionnaire A - Item 16

Each activity is designed to help children reach one or more of the objectives of DMP, and these objectives are identified as a part of the description of the activity. When given the objective, the teacher can find a related activity by reading the topic overview or the descriptions of the topic's activities.

22. The teacher re-directs individual students when they finish an activity.

Assessment: Observation Schedule - IV.8

This re-directing of students might involve beginning a new activity, peer tutoring on the activity just completed, or in some cases, working in an area other than mathematics. Re-directing need not involve formal assessment.

23. When given the appropriate information on student achievement,

the teacher classifies students into two groups--those that have sufficient mastery of prerequisite behaviors to start a new topic, and those that do not.

Assessment: Questionnaire A - Item 10

DMP assessments use the ratings of Mastery (M), Making Progress (P), and Needs Considerable Help (N) in determining student achievement of an objective. A student has sufficient mastery of prerequisite behaviors for a topic if he has no "N" ratings.

24. The teacher identifies the various options (including choice and sequence of activities) that are made available in each topic of the Teacher's Guide.

Assessment: Questionnaire A - Item 12

The DMP Teacher's Guide gives the teacher a number of choices about which activities to do in each topic. Some activities are strongly recommended; others are alternate or optional activities. In Questionnaire A, teachers are asked to identify recommended sequences of activities for a topic; supplementary information on this objective will be obtained by noting the selection of activities used by teachers during classroom observations.

Appendix B

INSTRUMENTS FOR GATHERING DATA

The Observation Schedule: DMP Inservice--Form 1

DMP Questionnaires for Teachers:

Questionnaire A
Questionnaire B
Questionnaire C

DMP INSERVICE--Form 1

I.	1. School			Date
	2. Activity			
	3. Previous			
	4. Next			
II.	1. Print			
	2. Manip.			
	3. Other			
III.	1. O M C			
	2. F			
	3. R			
	4. C			
	5. SW			
	6. D			
IV.	1. G			
	2. TM			
	3. SM			
	4. I			
	5. RO			
	6. A			
	7. RA			
	8. RD			
V.	1. U			
	2. P			
	3. C			
	4. A			
	5. Q			
	6. L			

DMP INSERVICE--Form 1

Observation Schedule

I. General Information

I.1. Identify the school, the observer (by initials), the teacher, and the date of the observation.

I.2. Give the label of the activity observed; if the activity is not taken from the Teacher's Guide, describe it briefly. If the teacher is in charge of students who are working on more than one activity, describe each of the activities. (Use labels, if possible.)

I.3. Find out from the teacher the activity done just previous to the one observed.

I.4. Find out from the teacher the activity that she plans to do next. If she has not decided which activity to do next, write "ND" and state any reasons that she may offer for not deciding until later.

II. Materials

II.1. Identify the DMP printed materials used.

II.2. Identify the manipulative materials used.

II.3. Identify other materials (e.g., crayons or graph paper) that are used in the activity and important to the success of the activity when these materials have been provided by the teacher.

III. Structuring Comments--Opening and Closing Activities

III.1. If the observation includes the opening of the activity (or a part of an activity), mark O; for the middle or closing of an activity, mark M or C, respectively.

III.2. F. Focus--The teacher identifies the problem and/or the objective of the activity (during the opening or the closing, usually). Yes No

III.3. R. Relationship--The teacher states the relationship of this activity to previous work. Yes No

III.4. *C. Clarity--The teacher explains or summarizes the activity clearly and in a well-organized manner, presenting ideas at a cognitive level appropriate for her students. Yes No

III.5. SW. Students Working--State the ratio of the number of students working profitably on the activity to the total number of students involved. 0 - less than 25%, 1 - 25% up to 50%, 2 - 50% up to 75%, 3 - 75% or more.

III.6. D. Displays--The teacher displays and discusses student work at the close of the activity as she works for cognitive closure. Yes No

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* High-inference

IV. Structuring the Classroom

IV.1. G. Grouping--The teacher organizes the students to work on the activity individually, in pairs, in small groups of 3 to 10, or in large groups of 11 or more. (Mark 1, 2, 3, or 4, respectively.)

IV.2. TM. Teacher Movement--The teacher moves from group to group (or individual to individual), acting as a resource person for the students. Yes No

IV.3. SM. Student Movement--Students move purposefully about the room to obtain materials, to consult with others, or for other task-oriented reasons. Yes No

IV.4. I. Student-Student Interaction--Students interact verbally while working on the activity. Yes No

IV.5. RO. Room Arrangement--The teacher arranges furnishings and materials in the room in a way that is appropriate for the activity. (For example, this behavior is demonstrated when the teacher puts several desks together to form a work area for a small group, following suggestions from the description of the activity.) Yes No

IV.6. *A. Assessment--The teacher assesses a student on the objectives of the activity by observation, i.e., the teacher observes a student apparently for purposes of assessment, whether or not the assessment is recorded. Yes No

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* High-inference

IV.7. RA. Records Assessment--The teacher records her observations of student achievement in the pupil performance records. Yes No

IV.8. RD. Re-Directs--The teacher redirects individual students when they finish an activity. Yes No

V. Teacher-Student Interaction

V.1. U. Use of student ideas--the teacher uses student ideas by repeating them, modifying them, applying them, comparing them to other ideas, or by summarizing them. Yes No

V.2. P. Probing--The teacher probes a student response--i.e., the teacher asks a student or a group of students to jusify or clarify a statement or to validate a mathematical statement. Yes No

V.3. C. Criticism--The teacher criticizes a student's contribution to a group discussion or to other group work. Yes No

V.4. *A. Authority--The teacher acts primarily as a mathematical authority figure rather than asking students to validate or justify their answers. Yes No

V.5. Q. The teacher asks questions about mathematical ideas related to the activity. Yes No

V.6. *L. The teacher uses lecture methods primarily rather than inquiry techniques when discussing mathematical ideas related to the activity. Yes No

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* High-inference

DMP QUESTIONNAIRES FOR TEACHERS*

These questionnaires are designed to gather information that will be used to improve DMP materials. Please feel free to expand upon your answers by writing in the margins or on the back of these pages.

Do not put your name on the questionnaire. Your response will be handled in an anonymous way, identified only by the code number. Thus you can feel completely free to be honest and direct in your answers.

There are often no "right" answers to questions. All that is requested is a frank statement of your opinions and practices, along with some background information.

The questionnaires are only one means of getting teachers' suggestions, and not every aspect of DMP is covered by these questionnaires. Considerable information has already been gathered from teachers, and more will be obtained later as R & D Center staff continue to look for ideas on how to improve DMP.

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* These questionnaires have been partially retyped to make them more compact.

QUESTIONNAIRE A

These questions deal mostly with DMP assessment materials. These materials are still being revised and improved, and your candid and critical comments will help with these revisions.

1. Do you regularly fill out Pupil Performance Records such as:
    a. Topic Checklists?
    b. Individual Progress Sheets?
    c. Group Record Card?
    d. Other record-keeping devices? (Please specify.)

2. For each of the Pupil Performance Records that you fill out, indicate how you use the information on it.
    a. Topic Checklists
    b. Individual Progress Sheets
    c. Group Record Card
    d. Other record-keeping devices (Please specify.)

3. If you did not fill out the Topic Checklists or Individual Progress Sheets, were there particular reasons why you found them to be unworkable or did not choose to use them?

4. What improvements do you suggest in DMP record-keeping procedures?

5. Have you administered:
    a. Placement Inventory A?
    b. Placement Inventory B?
    c. Level 1 Topic Inventories?
    d. Level 2 Topic Inventories?
    e. Other assessments? (Please specify.)

6. In what ways, if any, did you use the results of the assessments that you administered?
    a. Placement Inventory
    b. Topic Inventories
    c. Other assessments? (Please specify.)

7. From your point of view, state the purposes of:
    a. Placement Inventories
    b. Topic Inventories

8. If a student shows you his work, and he has written 6 + 3 = 8, how would you usually respond? (Check one or more responses, and add others if you wish.)

____a. I praise him even though his answer is incorrect.

____b. I ask him to change his work to make it correct.

____c. I ask him to show how he found his answer.

____d. I tell him that 6 + 3 = 9.

____e. Other (specify)

9. If a student shows you his work, and he has written 10 - 6 = 4, how would you usually respond? (Check one or more responses, and add others if you wish.)

____a. I praise him for getting the right answer.

____b. I ask him to show how he knows his answer is correct.

____c. I tell him that 10 - 6 = 4 because 4 + 6 = 10.

____d. I ask him to tell other children what the right answer is.

____e. Other (specify)

Some of the following questions deal with topics covered in the inservice workshops. Your responses will help us evaluate how clearly certain ideas were presented to you. In a later questionnaire you will be asked for suggestions on how to improve the inservice program.

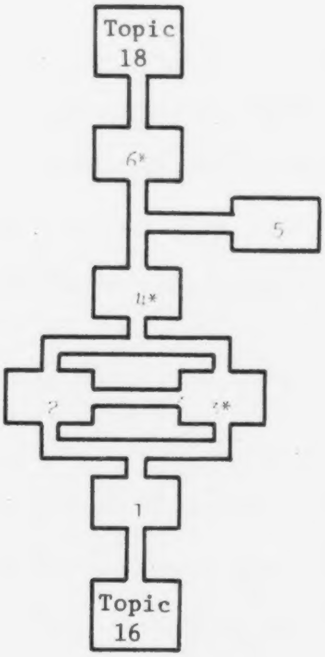
Checklist Topic 17	Objectives 1	2	3	4
Student A	M	M	P	M
B	P	P	N	N
C	M	P	N	P
D	N	P	N	N
E	P	M	M	P
F	M	N	P	P

10. Suppose that objectives 1, 3, and 4 are prerequisites for the next topic, and your Topic Checklist looks like the above. Which students are not ready to go on to the next topic?

11.
   a. Have you had any difficulty in making decisions about when your own students were ready to go on to the next topic?

   b. If yes, what were the difficulties and how did you handle them?

Suggested Sequence
of Activities
for Topic 17



12. On the basis of the sequence chart above, check any of the following sequences of activities which are choices that are recommended in Topic 17.

1, 4, 6

1, 2, 3, 4, 5, 6

1, 3, 4, 6

1, 2, 3, 4, 5

1, 2, 4, 6

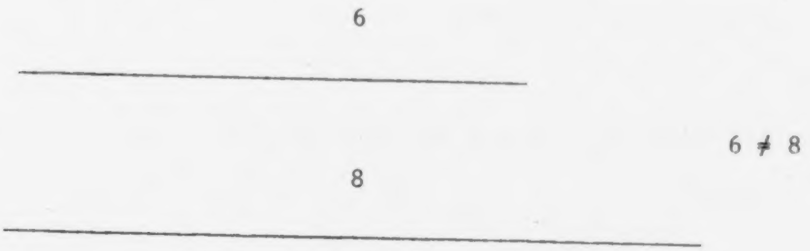
3, 4, 6

13. If some students needed more help, in which activities would one find additional suggestions?

14. a. Do you find the sequence charts helpful or not?

b. How could they be improved?

15. In describing the process of comparing to someone like a parent, you might include what students do or say or write when they use the process in solving a problem. For example, you might explain to a parent that students compare objects by telling whether they are alike or different in length or weight or some other way. If a student finds that one object is 6 units long and another is 8 units long, he would write 6 ≠ 8 to show the results of this comparison.



Give a brief description (a sentence or two) of each of the following processes as though you were explaining them to a parent.

a. Ordering

b. Equalizing

c. Validating

16. If a student needs to work on a certain objective in a DMP topic, how do you find activities in that topic that will help the sutdent reach the objective?

17.
   a. Do you find that the Teacher's Guide is organized conveniently for choosing activities?

   b. How would you improve the organization of the Teacher's Guide?

18.
   a. Do you find that the Assessment Manual is organized conveniently?

   b. How would you improve the organization of the Assessment Manual?

19. Please state any other reactions or comments related to the Teacher's Guide or Assessment Manual that you may have.

QUESTIONNAIRE B

The report of the DMP Field Test that you will receive will give a general description of the participating teachers and students. The purpose of Questionnaire B is to gather this general background information on teachers. Of course, this information will be reported only in terms of group data, such as average age, not as individual responses.

1. Please state the degrees you hold, the year when each degree was received, and the institution that granted the degree.

Degree	Year	Institution

2. Describe briefly any educational training that you have had in the past five years that is related to the topics listed below. Please include in your description the length of the training period and the name of the sponsoring institution.
   a. Elementary Mathematics

   b. Elementary Science

   c. Individualizing Instruction

   d. The "Open Classroom" or the British Infant Schools

   e. Team Teaching

3. How amny years of teaching experience do you have, including this year?

4. Please outline your teaching experience of the past five years.

School System	Grade Level	Dates

5. Have you been involved in the development and tryout of any other curriculum programs besides DMP? If yes, please give details.

6. Aside from your teaching, what other educational experience (if any) have you had in the past five years?

7. What is your age?

20 - 24 ____ 25 - 29 ____ 30 - 34 ____ 35 - 39 ____
40 - 49 ____ 50 - 59 ____ 60 or over ____

8. To what (if any) national, state, or local educational organizations do you belong?

9. What professional educational publications (if any) do you read regularly?

10. What (if any) professional meetings sponsored by educational organizations have you attended in the last three years?

QUESTIONNAIRE C

This questionnaire deals with opinions and attitudes about DMP and the inservice program. There are no right or wrong answers, so please be frank and honest in your replies. They will be of help in revising and improving DMP. Of course, your responses will be treated confidentially.

1. As a student my general attitude toward mathematics was:

Highly Unfavorable___	Moderately Unfavorable___	Mildly Unfavorable___	Mildly Favorable___	Moderately Favorable ___	Highly Favorable___

2. My general attitude toward teaching mathematics prior to this year was:

Highly Unfavorable___	Moderately Unfavorable___	Mildly Unfavorable___	Mildly Favorable___	Moderately Favorable___	Highly Favorable___

3. As a teacher of DMP, my general attitude toward teaching mathematics is:

Highly Unfavorable___	Moderately Unfavorable___	Mildly Unfavorable___	Mildly Favorable___	Moderately Favorable ___	Highly Favorable_

4. If your attitude toward teaching mathematics has changed, please explain what you believe caused the change.

5.
   a. Did you teach mathematics last year?
   b. If yes, what program or text did you use?

6.
   a. Do you teach mathematics differently this year because of DMP?
   b. If yes, please describe the differences. You may wish to refer to objectives, assessment materials, manipulative materials, small group work, planning time, or other factors that are related to DMP.

7. What do you like most about DMP? Why?

8. What do you like least about DMP? Why?

9.
   a. Overall, do you like or dislike DMP?
   b. Is it better or worse than programs or texts you have used in the past?
   c. In what ways?

10.
   a. If you attended a DMP summer workshop, was it useful or a waste of time?
   b. If it was useful, was it adequate or inadequate?
   c. How could it be improved?

11. Give your evaluation of the group meetings with Ron Lange, Wayne Neuburger, and (for Chicago teachers) Bernadette Perham.

12.* Give your evaluation of the individual conferences with Bernadette Perham.

13.
   a. Were you involved in making the decision to use DMP this year?
   b. If yes, how?
   c. If no, explain how you think the decision was made.

14.
   a. To what extent do you support the use of DMP in your school?
      Fully ____Moderately ____Slightly ____Not at all ____
   b. To what extent do you feel that your building principal supports the use of DMP in your school?
      Fully ____Moderately ____Slightly ____Not at all ____
   c. To what extent do you feel that the administration of your school system supports the use of DMP in your school?
      Fully ____Moderately ____Slightly ____Not at all ____
   d. What assistance have you received from your school system or from your principal that was particularly important in helping you use DMP?
   e. What assistance have you failed to receive that would have helped you in using DMP?

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* Chicago teachers only

Appendices C, D, and E have been
deleted from this publication, but
are available on microfilm at the
University of Wisconsin Memorial Library

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